



# **CSO Technologies Webcast**

## **Part 2**

**September 24, 2008**

**With:**

**Carol Hufnagel, Tetra Tech, Inc.**

**Mark Boner, Wet-Weather Engineering & Technology, Co.**

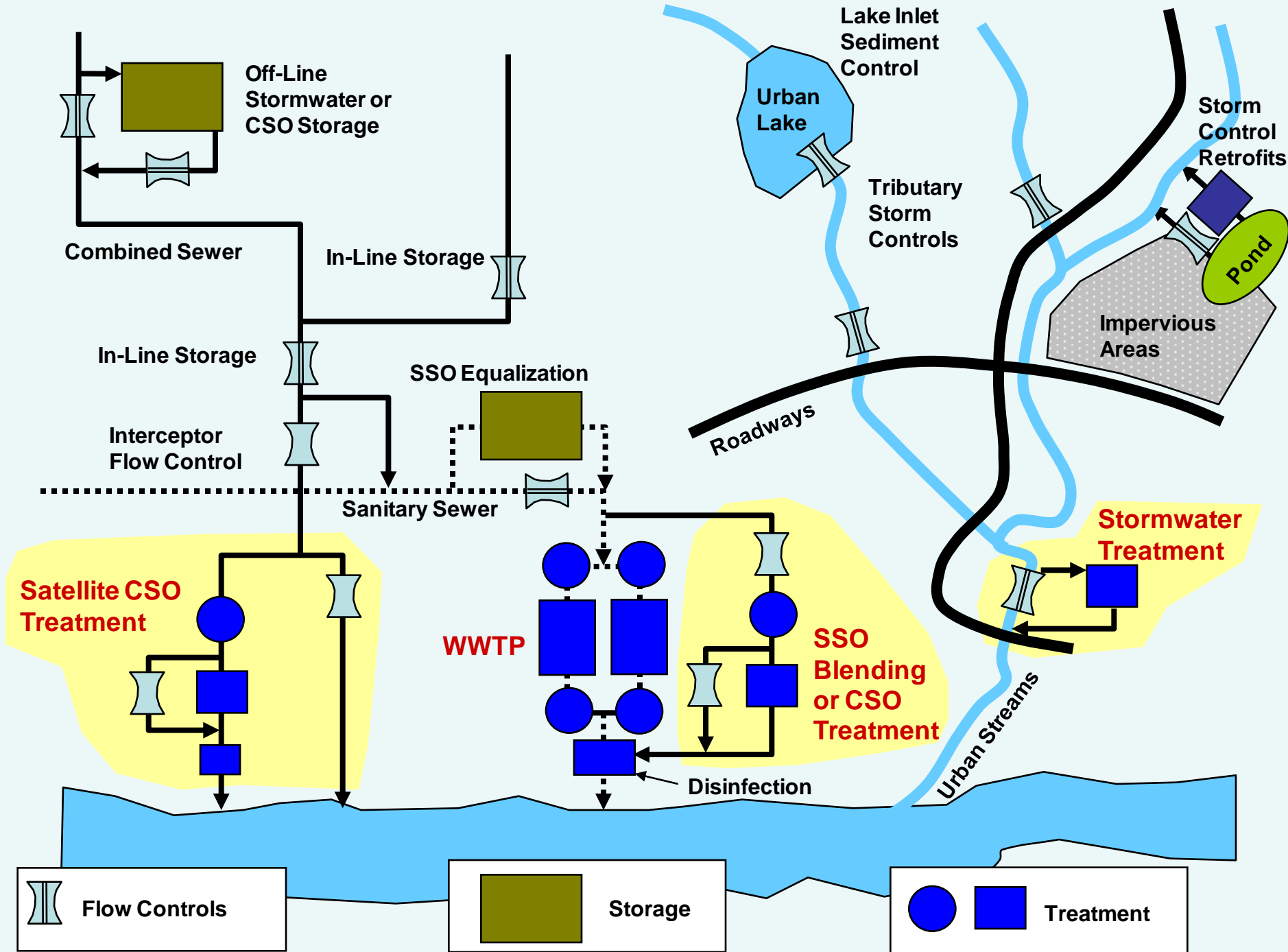
**Mohammed Billah, U.S. EPA**

# Guide to Our Webcasts

For Technical Support click the “**Help**” button

- **To Ask a Question** - Type your question in the text box located in the lower left-hand corner of your screen and click on the “Submit Question” button
- **To Answer a Poll Question** – Click on the radio button to the left of your choice and click submit. Do not type your answer in the “Ask a Question” box
- **To See Closed Captioning** – Turn your pop-up blocker off and click on the “closed captioning” button
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# **CSO Treatment Technologies**



# Case Study Programs

- **Atlanta CSO** – Screening, Tunnel Storage, Degritting, Settling, Filtration and Chemical Disinfection
- **Toledo CSO** – Screening, Degritting, Ballasted Flocculation and Chemical Disinfection
- **Columbus, GA CSO** – Screening, Vortex, Filtration and Chemical and UV Disinfection
- **Columbus, GA Stormwater** – Flow Control, Screening, Filtration and UV Disinfection
- **Multi-Use Technologies** – Dry & Wet Weather Biological Treatment and Peak Wet Weather High Rate Treatment
- **Disinfection and Compliance** – Chemical and UV Systems Design and Bacteria Compliance Determination



[www.cleanwateratlanta.org](http://www.cleanwateratlanta.org)

**Columbus, GA**

[www.cwwga.org](http://www.cwwga.org)

**Walter F. George Reservoir**



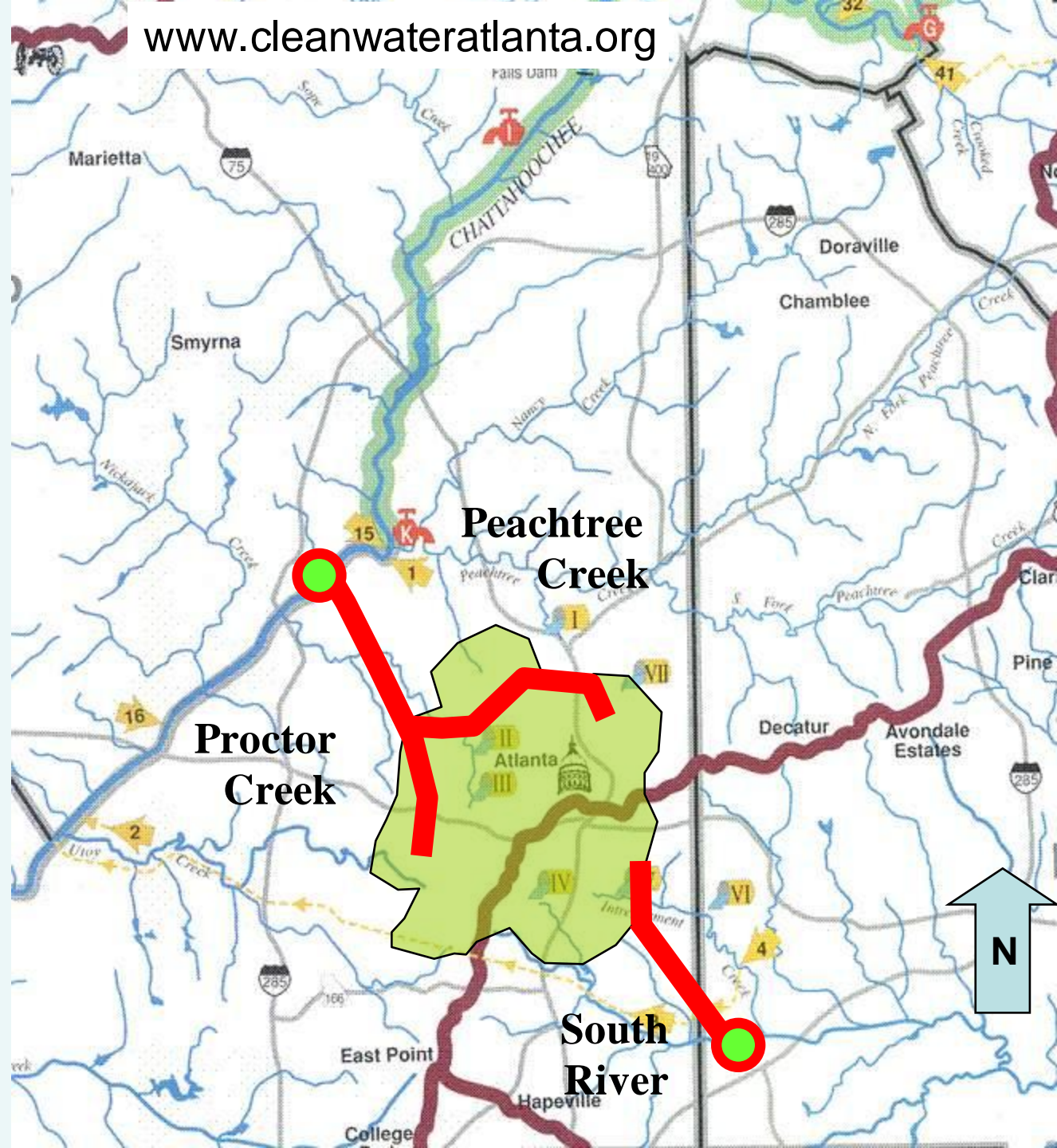
# Chattahoochee River Watershed

# City of Atlanta Wet Weather Program:

*1980s and 1990s  
CSO Controls*

## CSO Program Upgrades:

- 600% Increase in Tunnel Storage
- Upgraded CSO Residual Disinfection
- Upgraded CSO Treatment
- Select Sewer Separation (27%)





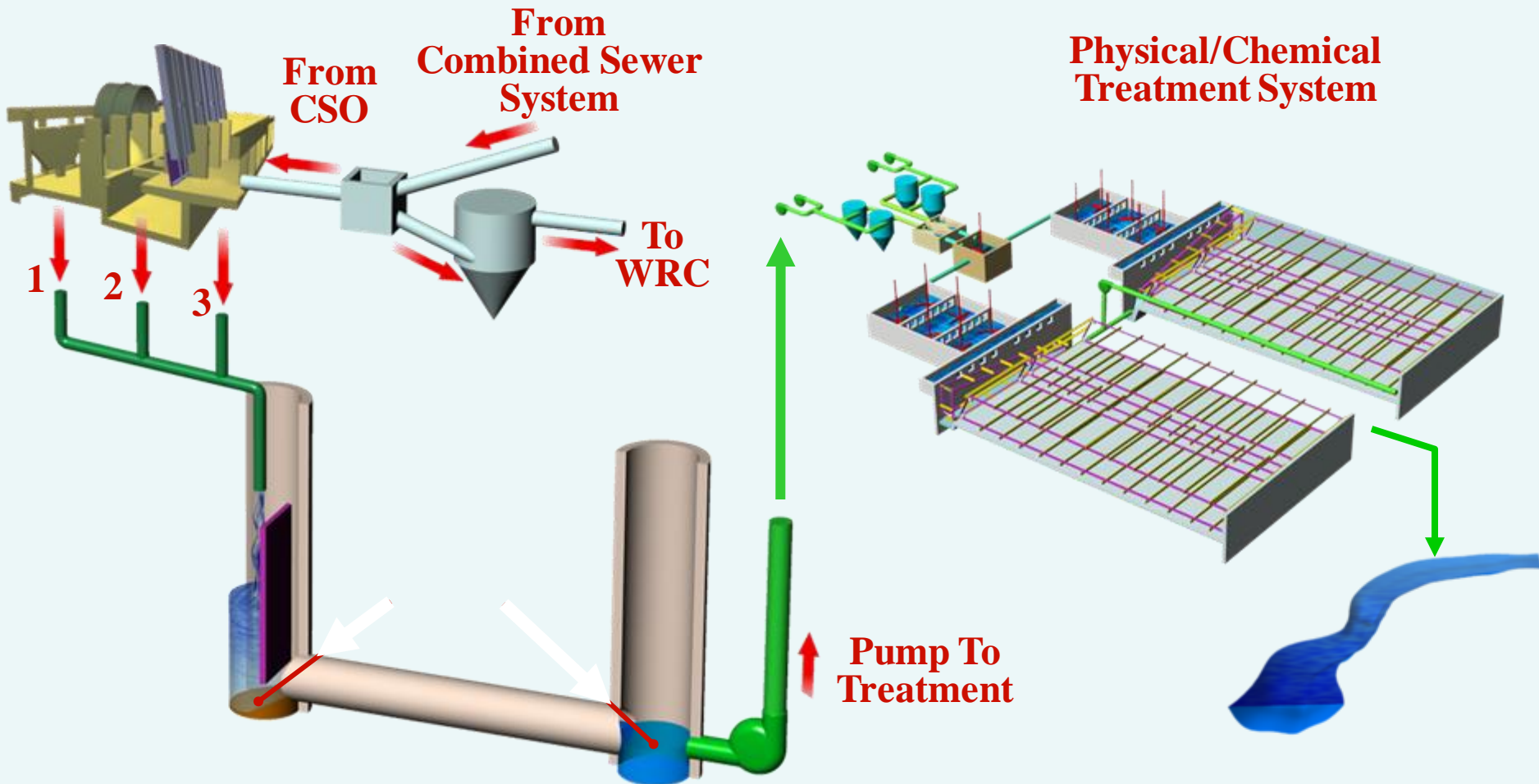
# **Atlanta CSO Cavern East Side Storage Facilities**



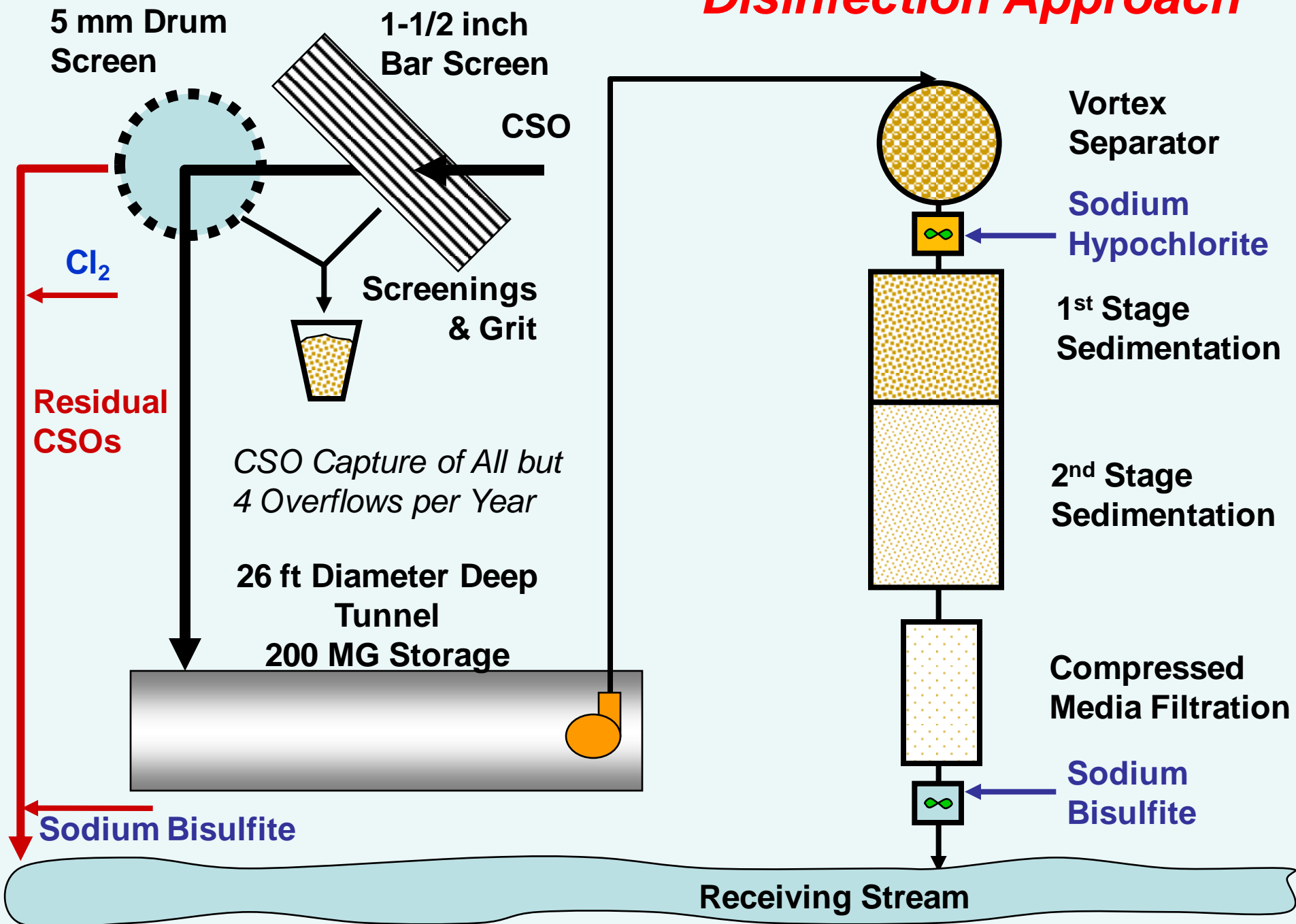


# Atlanta CSO Controls

## Tunnel Storage and Treatment

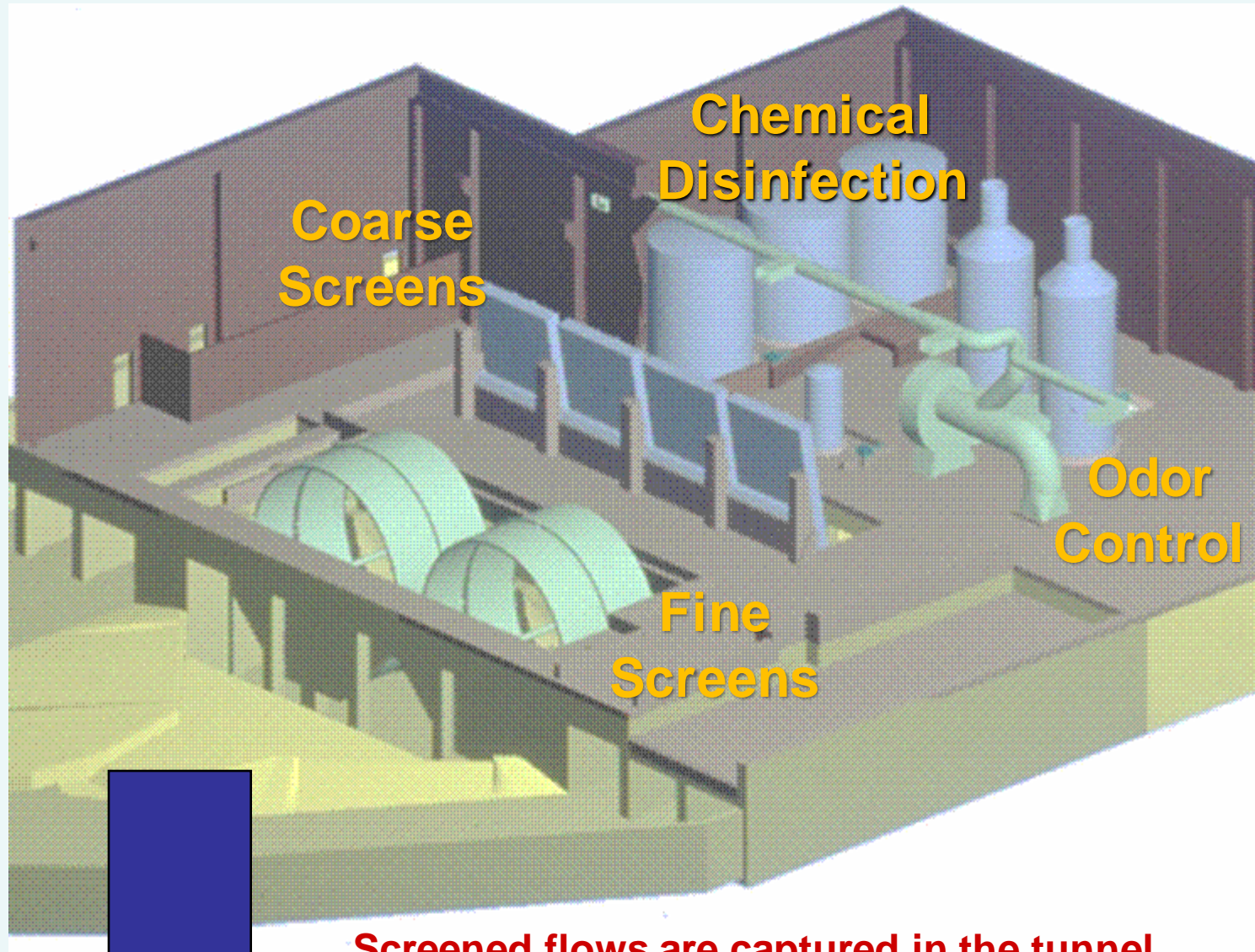


# Disinfection Approach



# Atlanta CSO Controls

## Screening and Disinfection at CSO



Residual CSOs receive sodium hypochlorite disinfection and sodium bisulfite dechlorination.

Screened flows are captured in the tunnel up to and average of all but 4 per year.



**Climber  
Type Bar  
Screens**

**Atlanta CSO  
Screening**

**Perforated Plate  
Drum Screens**







**Bending Weirs to maximize  
flow into tunnel before  
residual CSOs to stream**

**Area for grit  
sedimentation  
before flow to  
tunnel**





Emergency  
Tunnel Overflow

Tunnel  
Pump  
Station

Dechlorination  
& Parshall  
Flume

Compressed  
Media Filters

Sedimentation  
Basins

Vortex  
Separators

Drum  
Screens

Detritus  
Separators



# Sedimentation Basins



09.17.2007

# Filters





# Sodium Hypochlorite Disinfection



09.17.2007

# **Atlanta CSO Performance Requirements**

- **Monthly Reports of Events, Bacteria, TSS, Ammonia, Phosphorous and TRC - Fecal Coliform and TRC Limits – No Violations**
- **Annual Report of Events with TSS and BOD<sub>5</sub> Removal Requirements of 60% and 25%, Respectively - Work-In-Progress**
- **One Time Post Construction Metals Sampling and Bio Monitoring Evaluation to Confirm No Metal Limits, As in Earlier Studies, Using GA “No Reasonable Potential Determination” – Work-in-Progress**
- **One Time Permit Cycle Priority Pollutant Scan - Complete**

# Atlanta CSO Capital Costs

<b>Component</b>	<b>Total Cost Millions</b>	<b>\$ per Acre</b>	<b>\$/gallon Storage Capacity</b>	<b>\$/gallon Treatment Capacity</b>
<b>Sewer Separation</b>	<b>\$285</b>	<b>\$78,100</b>	<b>\$5.65</b>	<b>\$10.06</b>
<b>Tunnel</b>	<b>\$287</b>	<b>\$21,200</b>	<b>\$1.53</b>	<b>\$2.73</b>
<b>Treatment</b>	<b>\$94</b>	<b>\$7,000</b>	<b>\$0.50</b>	<b>\$0.90</b>
<b>Total CSO</b>	<b>\$666</b>	<b>\$49,200</b>	<b>\$3.56</b>	<b>\$6.35</b>

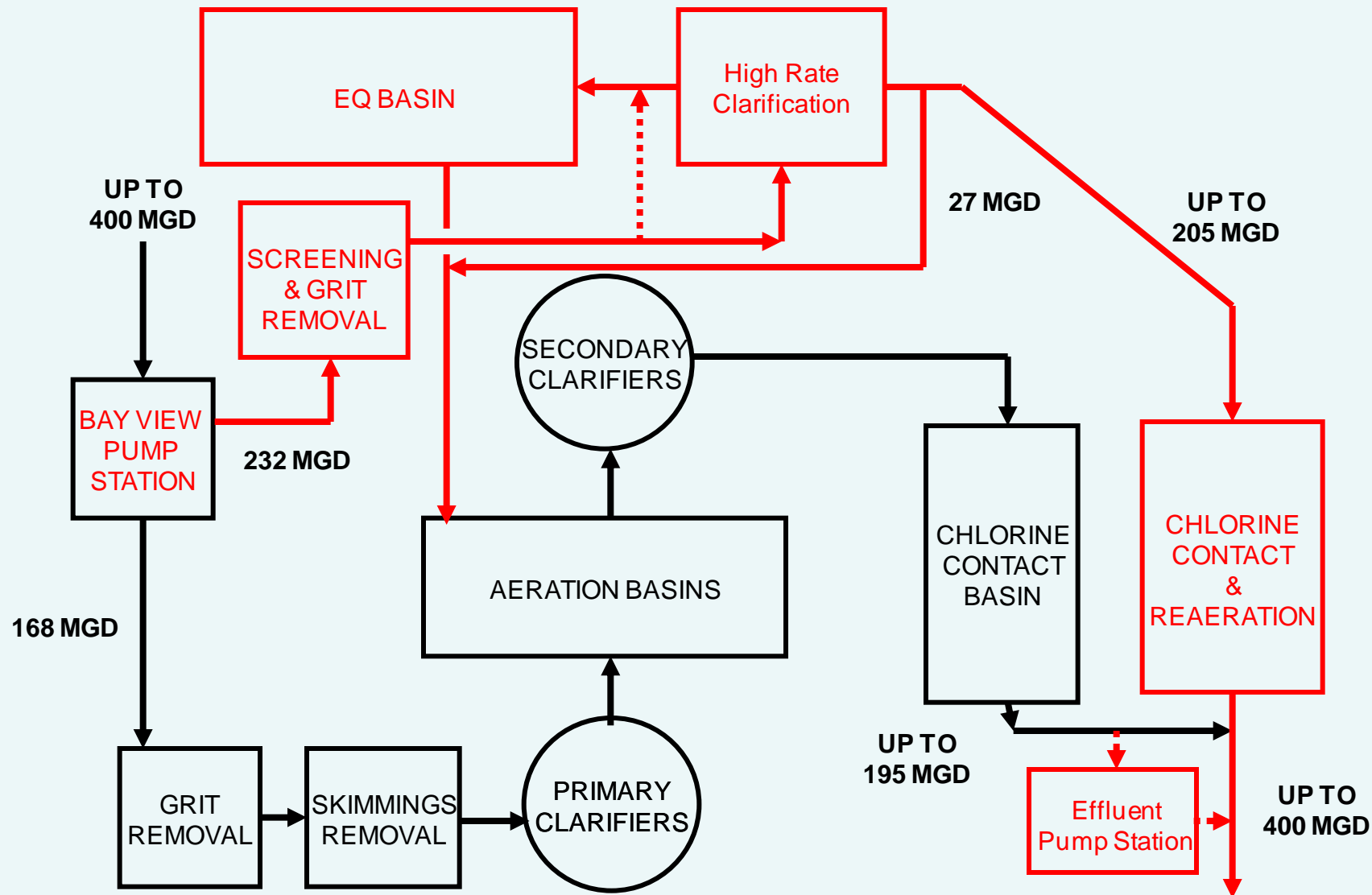
Costs per acre or per gallon for sewer separation are based upon proportion of total CSS area, however tunnel and treatment are based upon and designed for entire CSS area of 13,500 acres.

# Bay View WWTP Flows

[www.csop.com/conferencepresents.htm](http://www.csop.com/conferencepresents.htm)

- **Toledo, OH – wet weather consent decree**
- **Bay View WWTP flows:**
  - 45 MGD dry weather
  - 70 MGD average annual
  - 130 MGD peak month
  - 195 MGD secondary treatment capacity
  - 400 MGD peak hour
- **Wet weather improvements:**
  - **Equalization**
  - **Wet Weather Treatment**





## NEW WET WEATHER FACILITIES

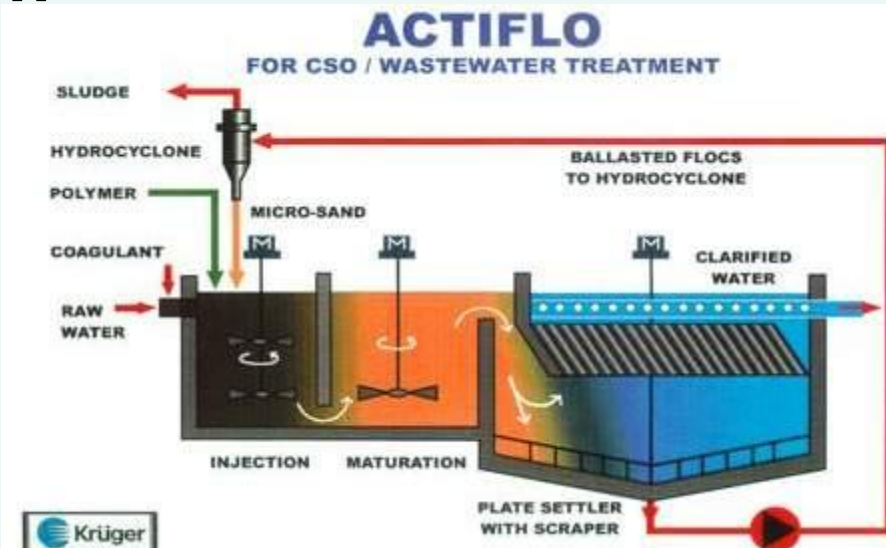
# HRT Evaluation Factors

- Discharge Requirements
- Frequency of Use/Chemical Usage
- Pretreatment Needs
  - Pumping
  - Fine Screening
  - Grit Removal
- Odor Control
- Startup & Shutdown Requirements
- Solids Handling Requirements
- Flexibility to Use for Primary & Tertiary Treatment

# Actiflo Design Considerations

[www.krugerusa.com](http://www.krugerusa.com)

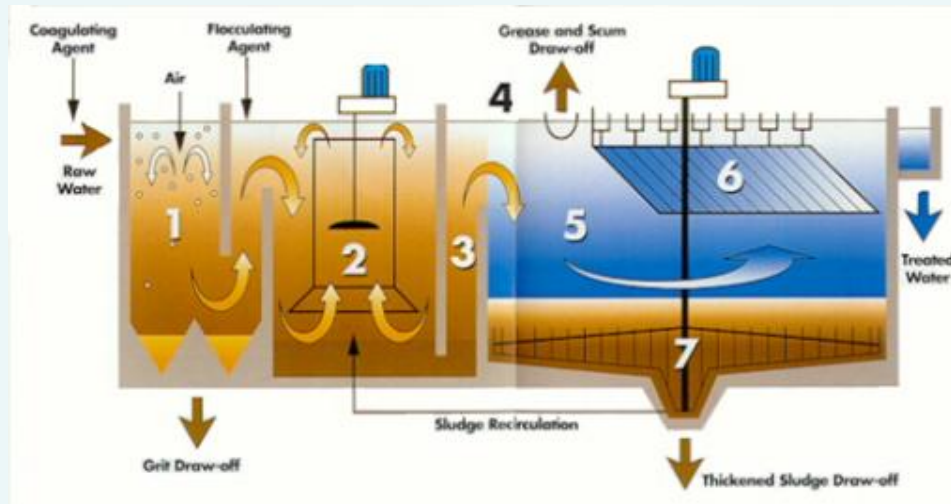
- Fine Screening ( $\leq 1/4$  inch openings)  
*f (Hydrocyclone opening)*
- Requires Grit Removal
- Thin Sludge (<0.5% solids);  
Volume ~ 2 to 3% of Influent Flow  
(= capacity of recirculation pumps)
- Media Recirculation & Cleaning System



# *DensaDeg* Design Considerations

[www.infilcodegremont.com](http://www.infilcodegremont.com)

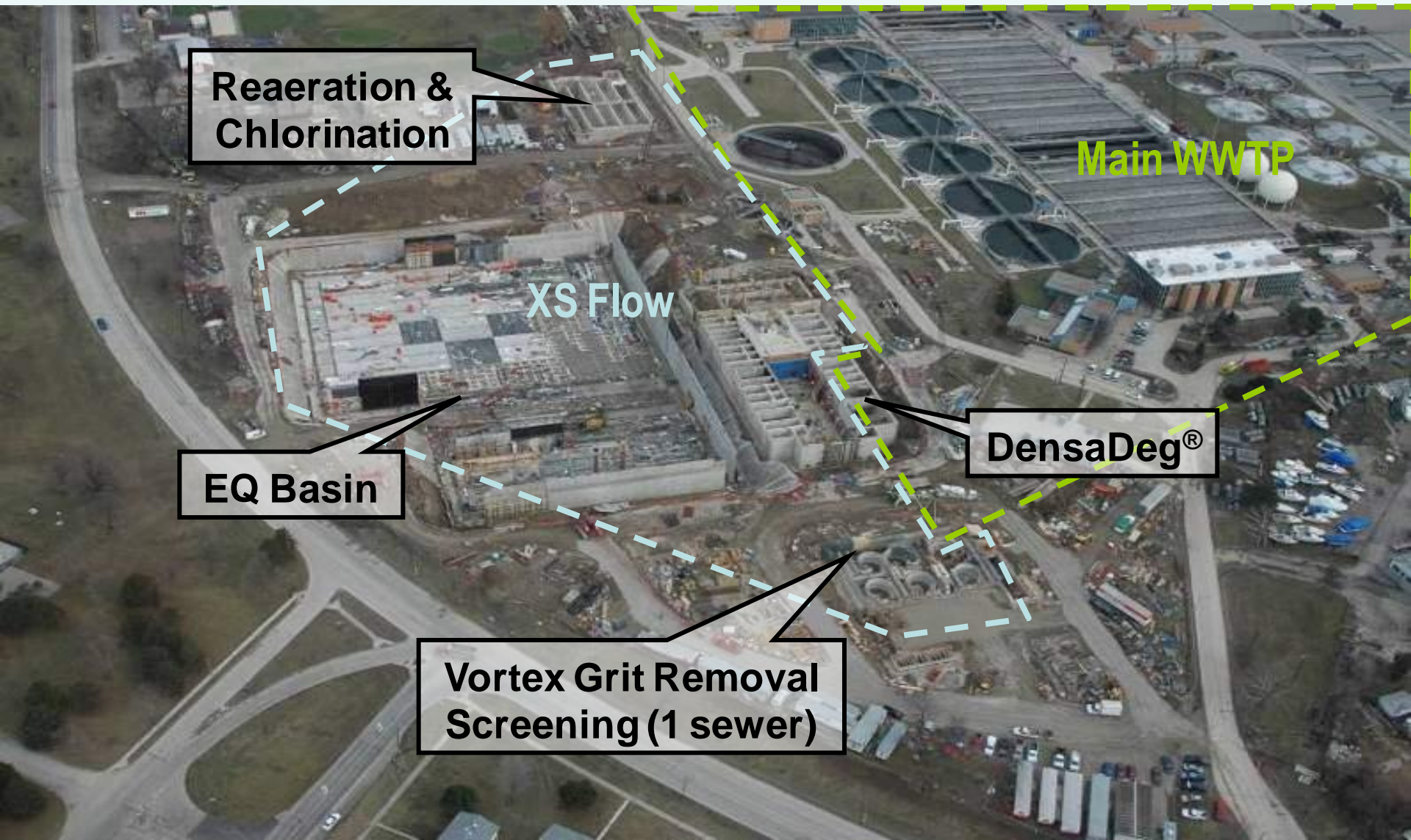
- Fine Screening ( $\leq 1/2$  inch openings)
- Concentrated Sludge (3 to 4% solids)
- Slower Startup Due to Reliance on Sludge Recirculation
- Potentially deeper settling compartment than *Actiflo*
- Less Consistent Performance Due to Ballast Media (Sludge) Variability





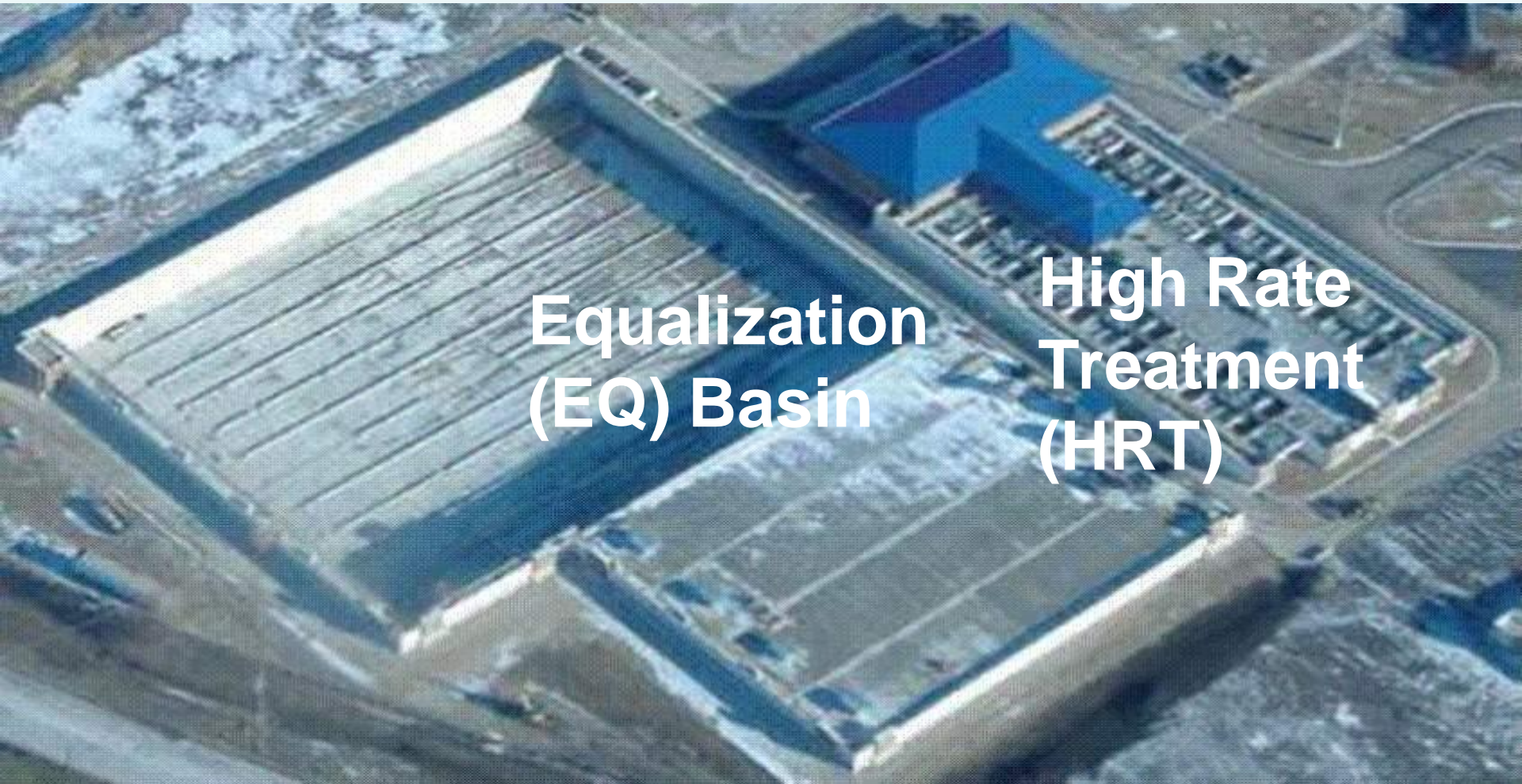
# Toledo, Ohio

## Bay View Wastewater Treatment Plant





# HRT and EQ Basin





# Toledo, OH DensaDeg® HRT





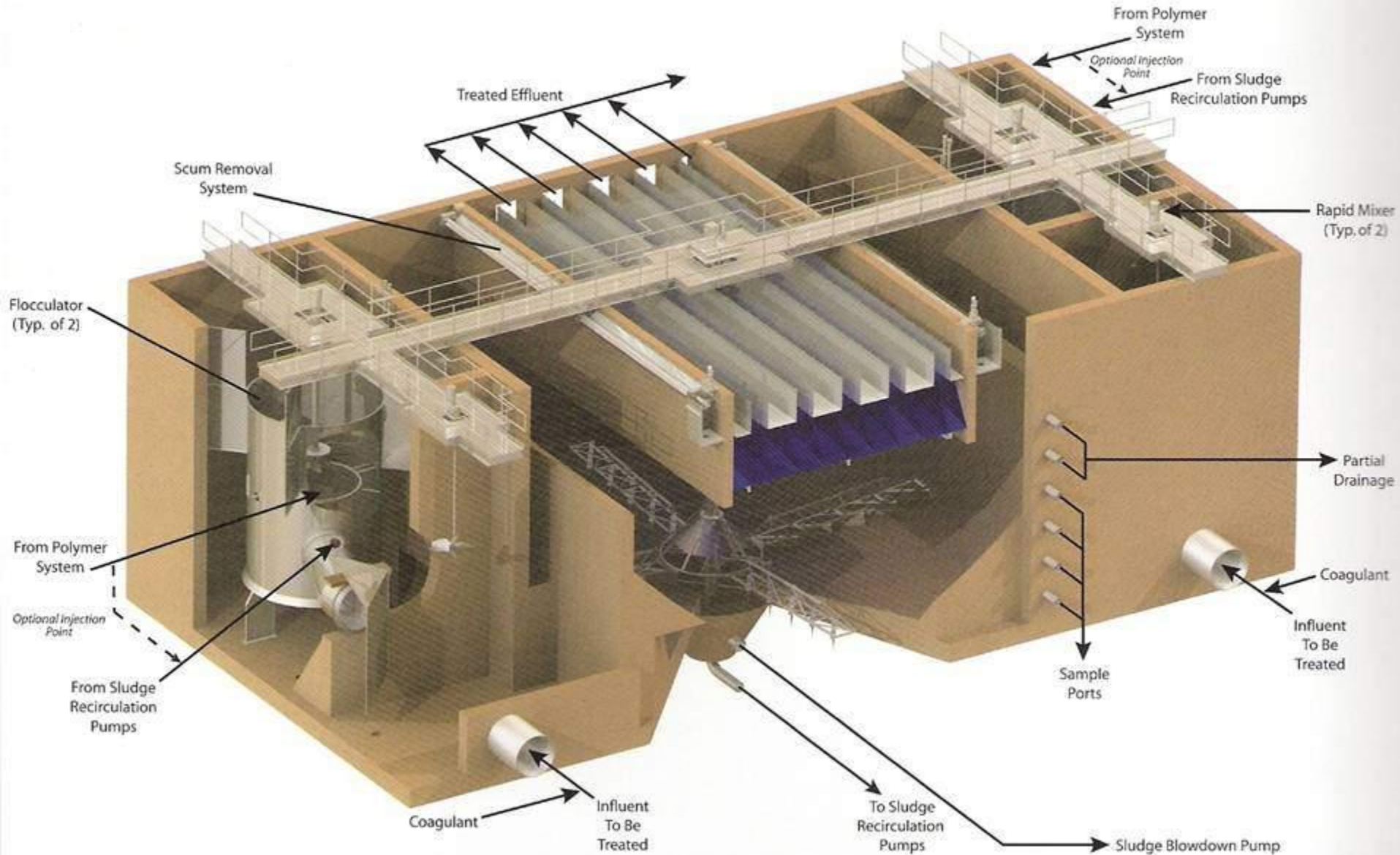
# HRT Pipe Gallery and Sludge Pumps





# HRT Cells

## *Dual Feed DensaDeg® 2D-100*





# HRT Treatment Results

- **Performance testing results:**
  - Effluent TSS 7 to 38 mg/L with average of 25 mg/L.
  - TSS removal averaged approximately 80%.
  - Effluent CBOD 22 to 177 mg/L with average of 52 mg/L.
  - CBOD removal averaged approximately 55%.
  - Mixture of dry and wet weather conditions during performance testing.
- **2-year effectiveness study ongoing thru 2008**

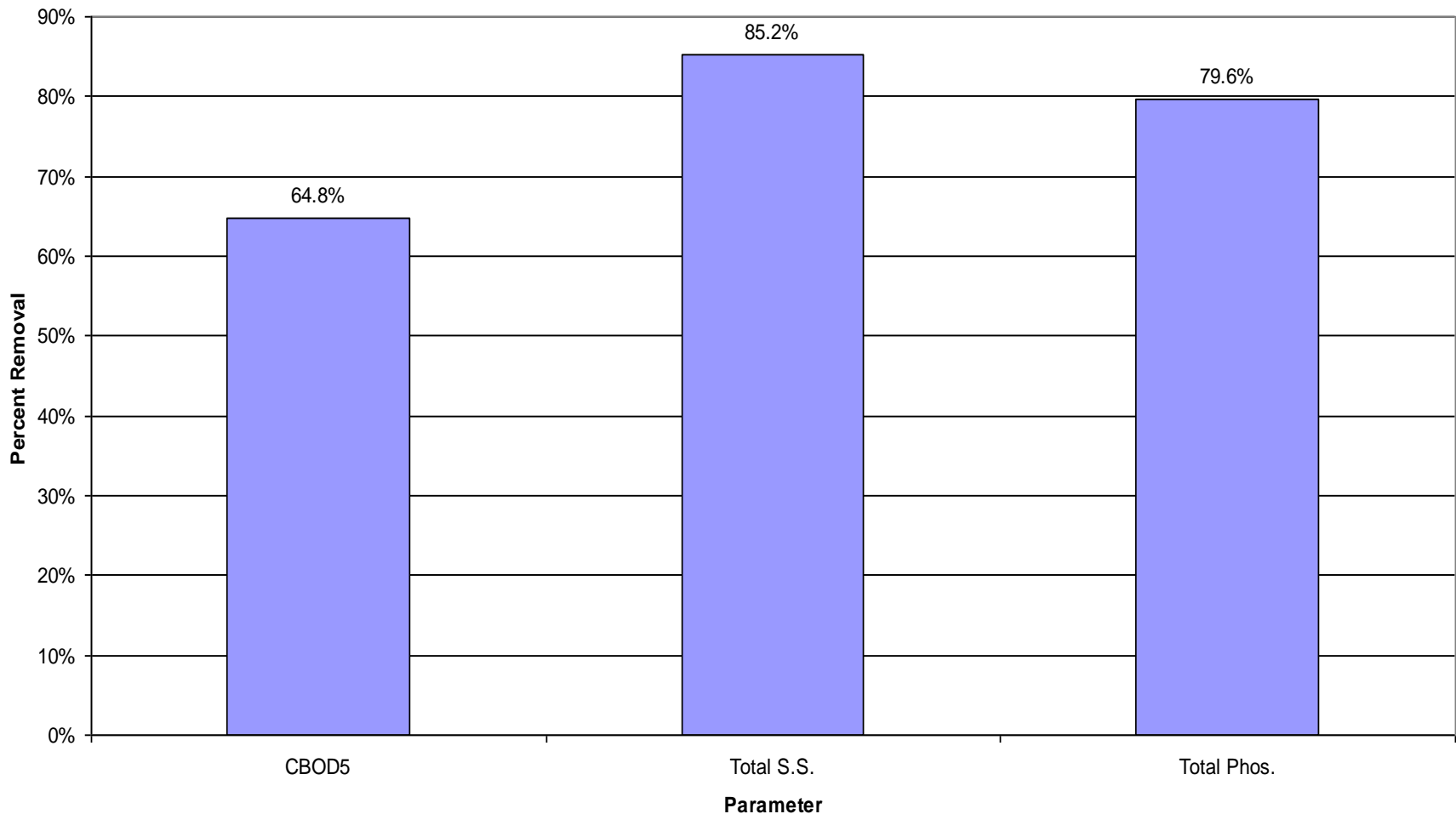
# First 6 Months of 2-year Effectiveness Study

<b>Dates</b>	<b>Duration hrs</b>	<b>Total Precipitation, in</b>	<b>Total Peak Flow, MGD</b>	<b>Peak Flow to BF, MGD<sup>1</sup></b>
<b>April 25, 2007</b>	<b>8</b>	<b>1.30</b>	<b>285</b>	<b>165 (133)</b>
<b>April 26-27, 2007</b>	<b>18</b>	<b>1.02</b>	<b>253</b>	<b>124 (94)</b>
<b>June 3-4, 2007</b>	<b>18</b>	<b>1.05</b>	<b>267</b>	<b>118 (88)</b>
<b>August 19, 2007</b>	<b>14</b>	<b>1.88</b>	<b>219</b>	<b>104 (71)</b>
<b>August 20-21, 2007</b>	<b>23</b>	<b>2.00</b>	<b>380</b>	<b>153 (116)</b>

<sup>1</sup> Total flow (flow directed to EQ Basin or wet weather disinfection).  
Effluent from Units 1 and/or 3 normally directed to aeration basins

# Wet Weather Treatment System Performance

Toledo Ballisted Floc Wet Weather Treatment Facility  
CBOD, TSS and Phosphorous Average % Removals Since Startup



# **Performance Effectiveness Study**

- **Ongoing 2-year performance testing**
- **Proposed performance testing to evaluate effectiveness in removal of virus/ pathogens**
- **Facility optimization ongoing process**
- **Have met final effluent limitations at flows up to 390 MGD**



# HRT Construction Costs

Item	Cost *
Influent Screening / PS Modifications	\$ 12 million
Grit Removal	\$ 14 million
HRC Treatment Basins	\$ 33 million
Chlorine Contact Basin/Effluent Outfall	\$ 5 million
Chemical Storage and Feed	\$ 3 million
* Year 2006-7	<b>Total \$ 67 million</b>

**232 MGD Capacity**

***\$0.29/gpd***

# HRT Annual O&M Costs

Item	Cost *
Ferric Chloride	\$22,000
Polymer	\$20,000
Maintenance Labor @ \$30/hr	
•Sludge level meter rebuild (6 @ 1 hour each)	\$180
•Mixer and scraper oil and lube (30 @ 8 hours each)	\$7,200
•Sludge pump oil and lube (24 @ 0.63 hours each)	\$450
•Flush and clean HRC basins (3 units x 5 hours x 15 events)	\$6,750
•Equipment Diagnostics (2 hours per week)	\$3,300
•Instrument Calibration (14 @ 1.7 hours each)	\$720
•Metering Pump Calibration (28 @ 0.86 hours each)	\$720
•HVAC filter change (40 hours)	\$1200
•Miscellaneous (96 hours)	\$2,880
Maintenance Consumables (oil, grease, probes, etc.)	\$9,750
Operations Labor @ \$30/hr x 224 hrs/yr	\$13,440

\* Year 2007

**Total**

**\$88,590**

**Treating ~1000 MG/yr**

**\$ 89/MG**

# **Poll Question 1:**

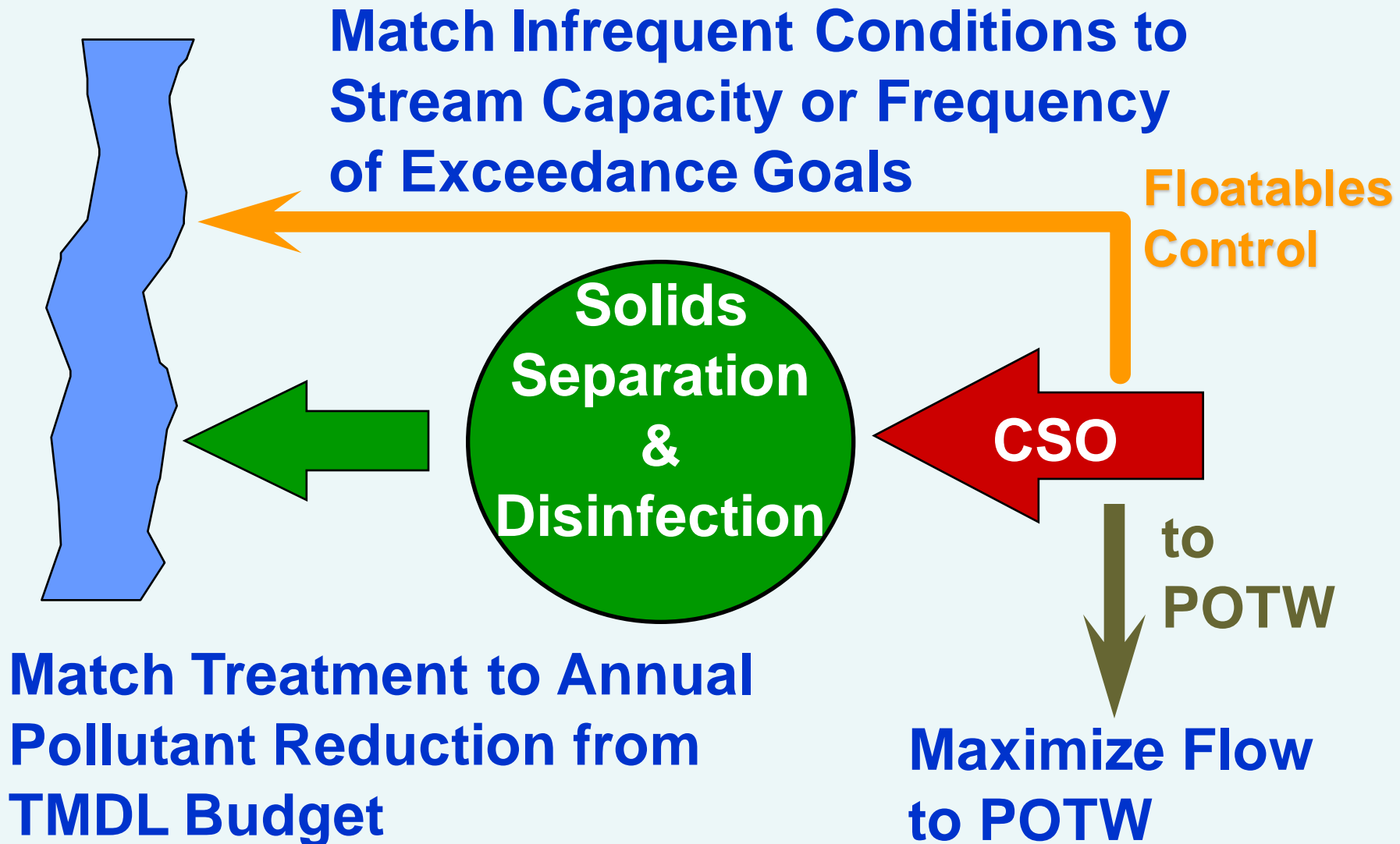
## **Who do you represent?**

- A) A Small CSO Community (city, county)
- B) A Large CSO Community (town, city, county, other)
- C) State/federal government
- D) Consultant assisting municipalities
- E) Industry
- F) Other

***Questions?***



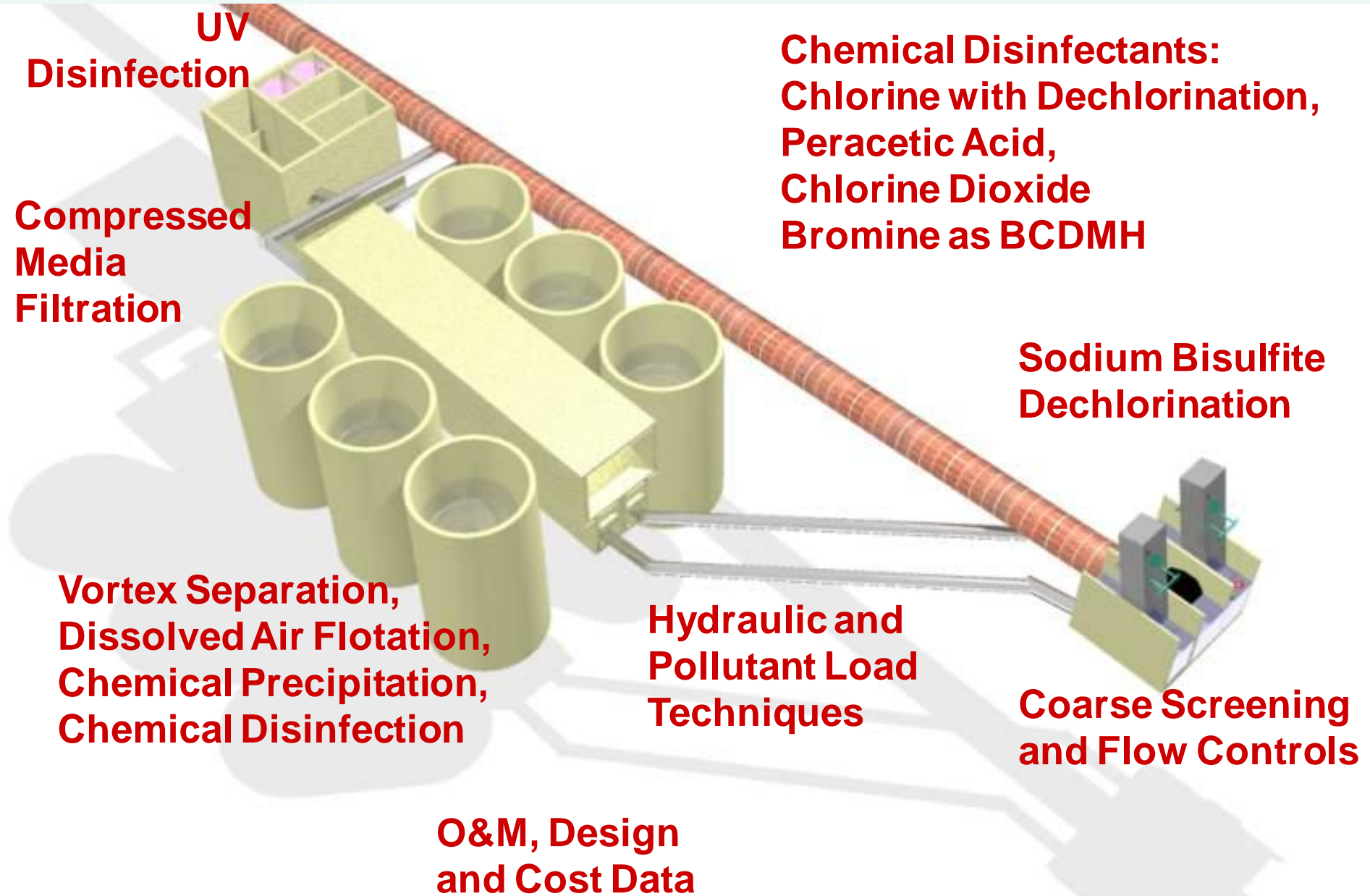
# CSO Treatment Process Flow Diagram



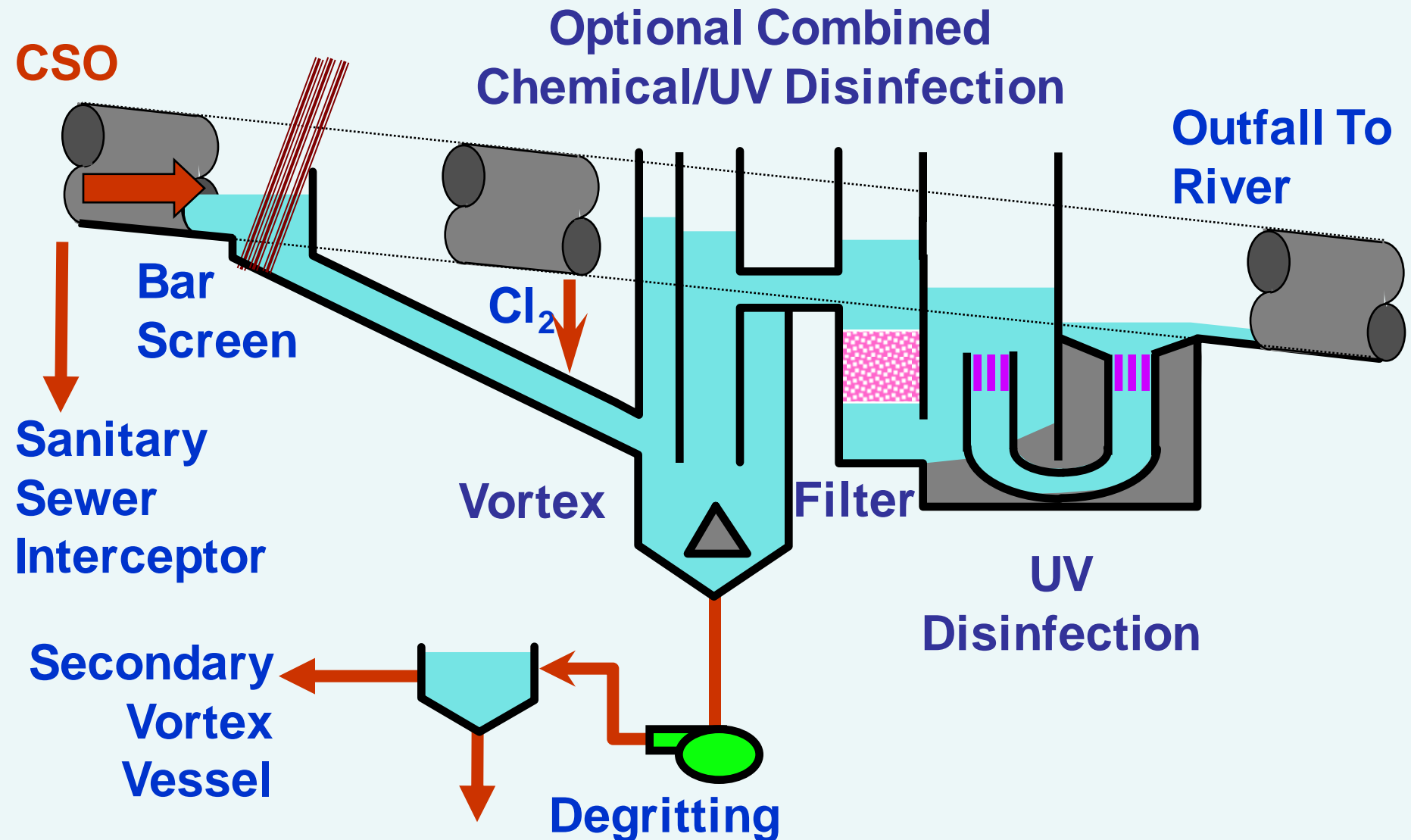
# Uptown Park Water Resources Facility



# Columbus, GA Technology Demonstration

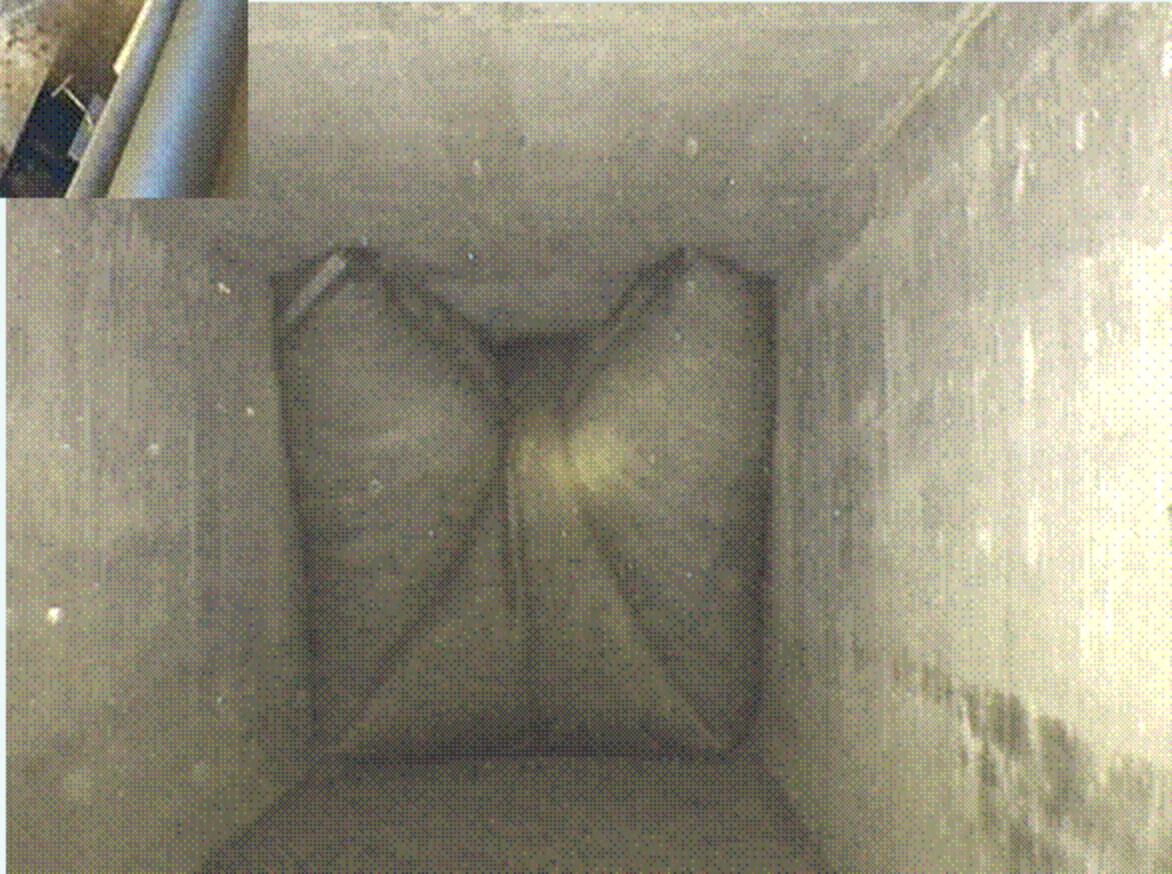


# High Quality Treatment After Storage Capacity Is Exceeded





# Floatables and Flow Control



# 1-1/2 inch opening climber type bar screening facilities



# Vortex Separator





# Grit Separation and Handling





**Compressed Media Filtration**  
**High Hydraulic Loading**  
**High Solids Loading**  
**Quality Treatment**  
**Applicable to Wet Weather**



# **Sodium Hypochlorite System**

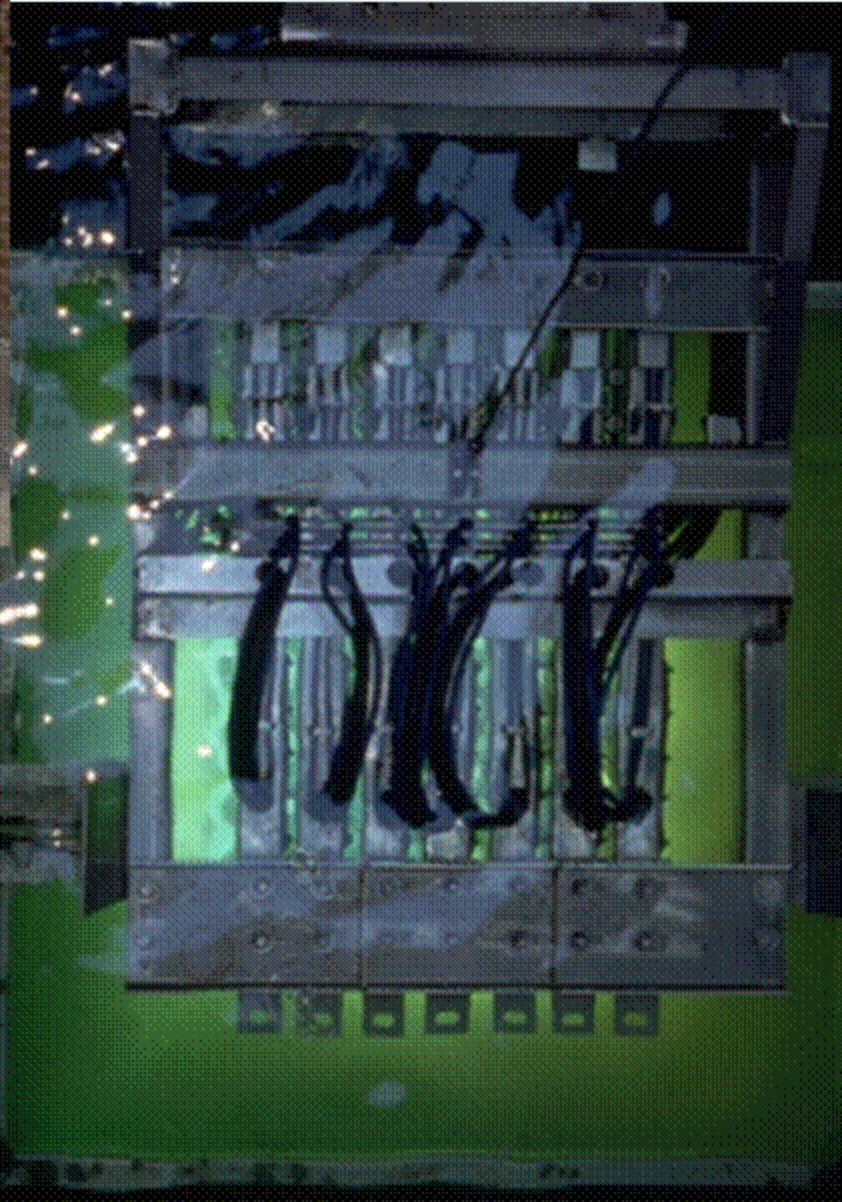
## **Sodium Bisulfite for Dechlorination**







# Medium Pressure UV Disinfection



# **Columbus CSO Performance**

## **(In It's Third Permitting Cycle)**

- **Monthly Report of Events, Bacteria, TSS and Phosphorous (No Limits) – Results:**
  - Fecal Coliform <100,
  - 81% TSS removal,
  - River Sampling and TMDL Compliance Analysis
- **Comprehensive Multi-Year Post-Construction Watershed Monitoring and Modeling Study and Water Quality Compliance Analysis - Complete**
- **TMDL Evaluation and Implementation Plan with State No Reasonable Potential Analysis to Support “No CSO Effluent Limits” – Complete**
- **One Time Permit Cycle Priority Pollutant Scan - Complete**



# Columbus CSO Capital Costs

Component	Total Cost Millions	\$ per CSO Acres	\$/gallon of Treatment Capacity
Sewer Separation	\$5.4	\$57,447	\$1.18
Transport	\$34	\$13,077	\$0.28
Treatment	\$43	\$16,538	\$0.36
Optimized Treatment	\$35	\$13,462	\$0.16
Program and Study Costs	\$13	\$4,962	\$0.11
<b>Total CSO</b>	<b>\$95</b>	<b>\$36,654</b>	<b>\$0.79</b>

Costs per acre or per gallon for sewer separation are based upon proportion of total CSS area, however transport and treatment are based upon and for the entire CSS area of 2600 acres. Optimized treatment allows an 85% flow increase and excludes capital for extra technologies.

# Columbus CSO Operating Costs

O&M Cost Item	Annual O&M Cost, \$Thousand	Annual O&M Labor Hours	Present Worth O&M, \$Million	Present Worth O&M / Capital
Labor	\$265	8,620	\$2.7	2.8%
Power and Chemicals	\$156		\$1.6	1.6%
Supplies and Replacements	\$98		\$1.0	1.0%
Laboratory	\$20		\$0.2	0.2%
Total O&M	\$539		\$5.7	5.7%

Area of responsibility for people operating, monitor and perform 95% of all CSO system and group maintenance.

# Columbus, GA



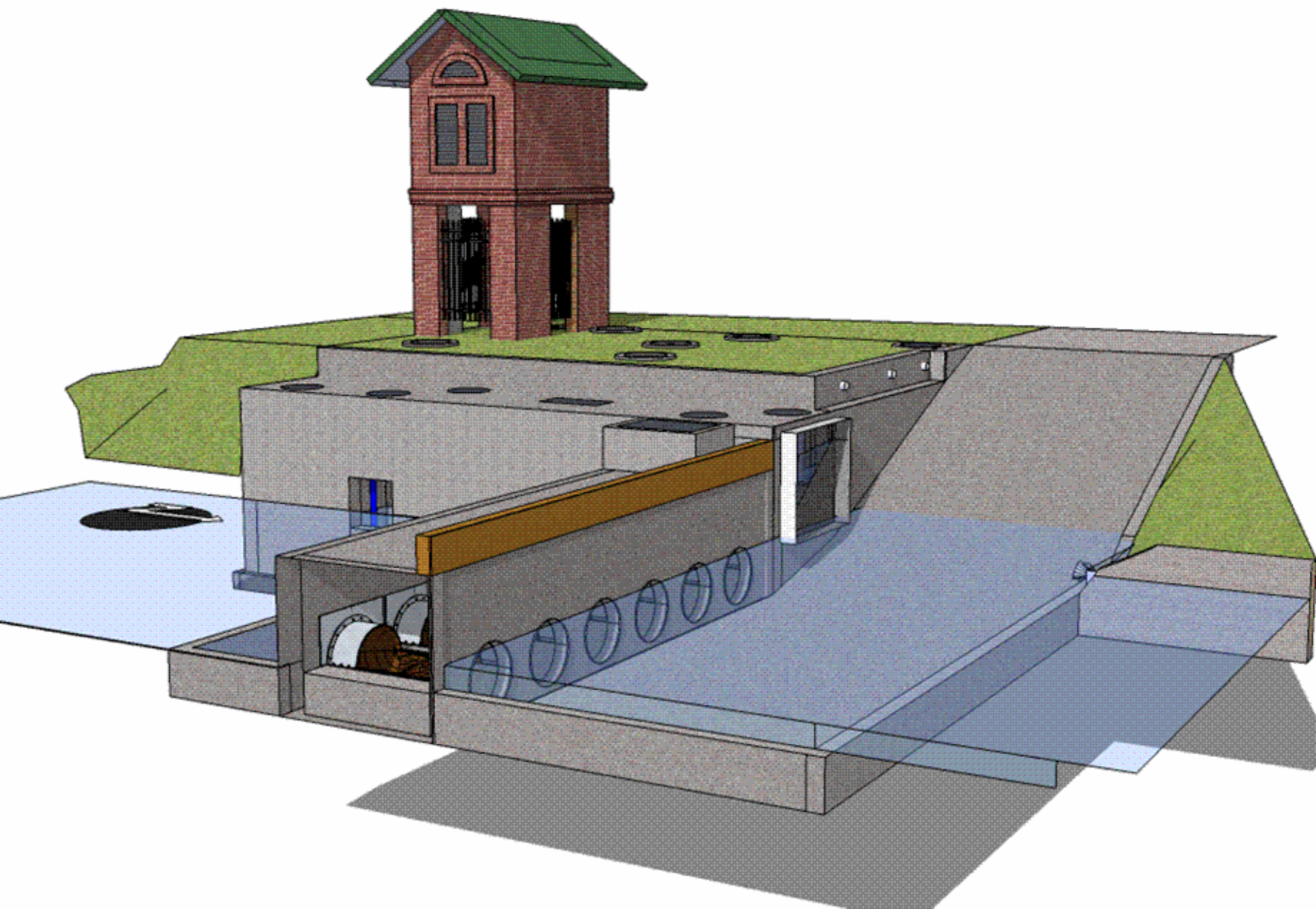
**Weracoba Creek BMP**

**Stormwater Attenuation, Filter and UV Disinfection**

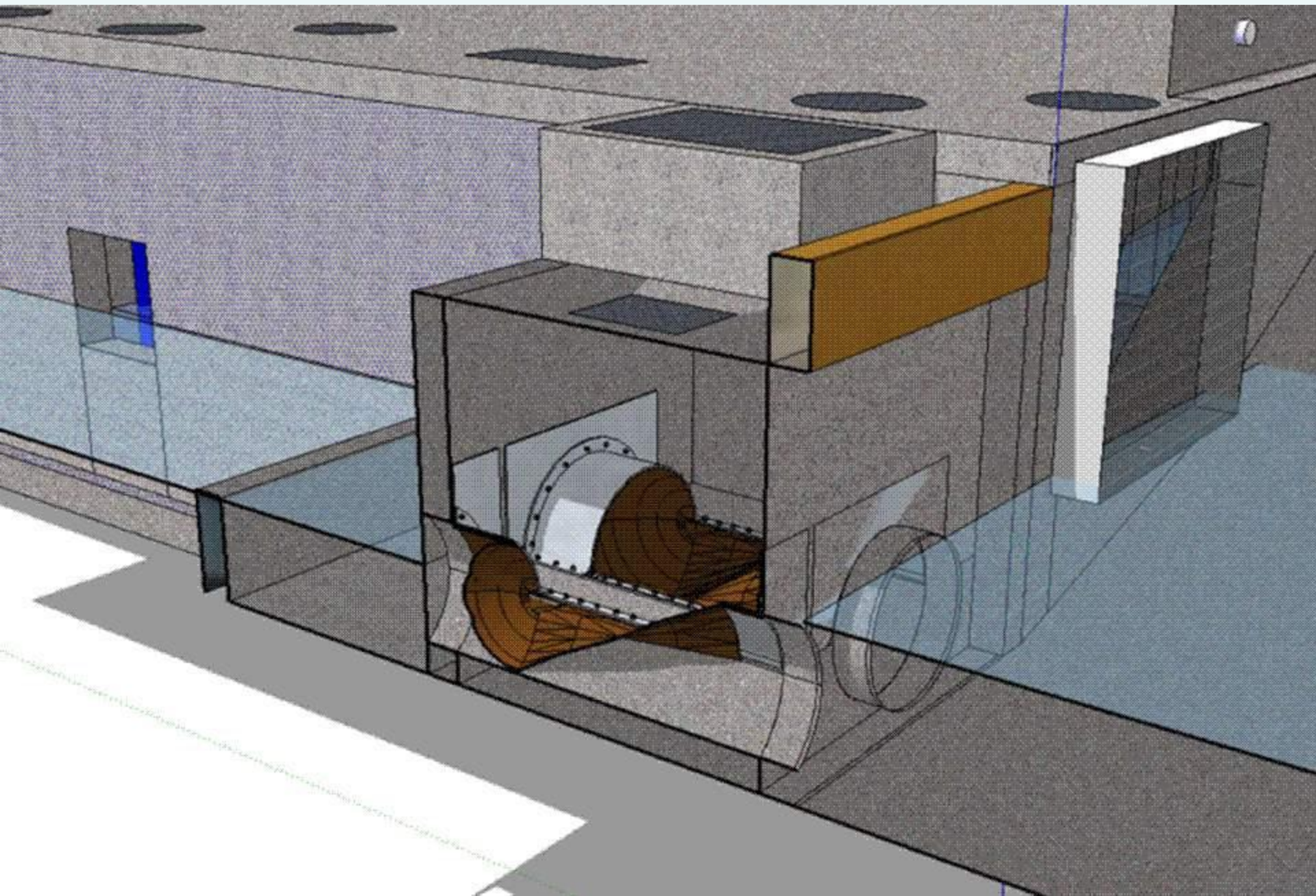








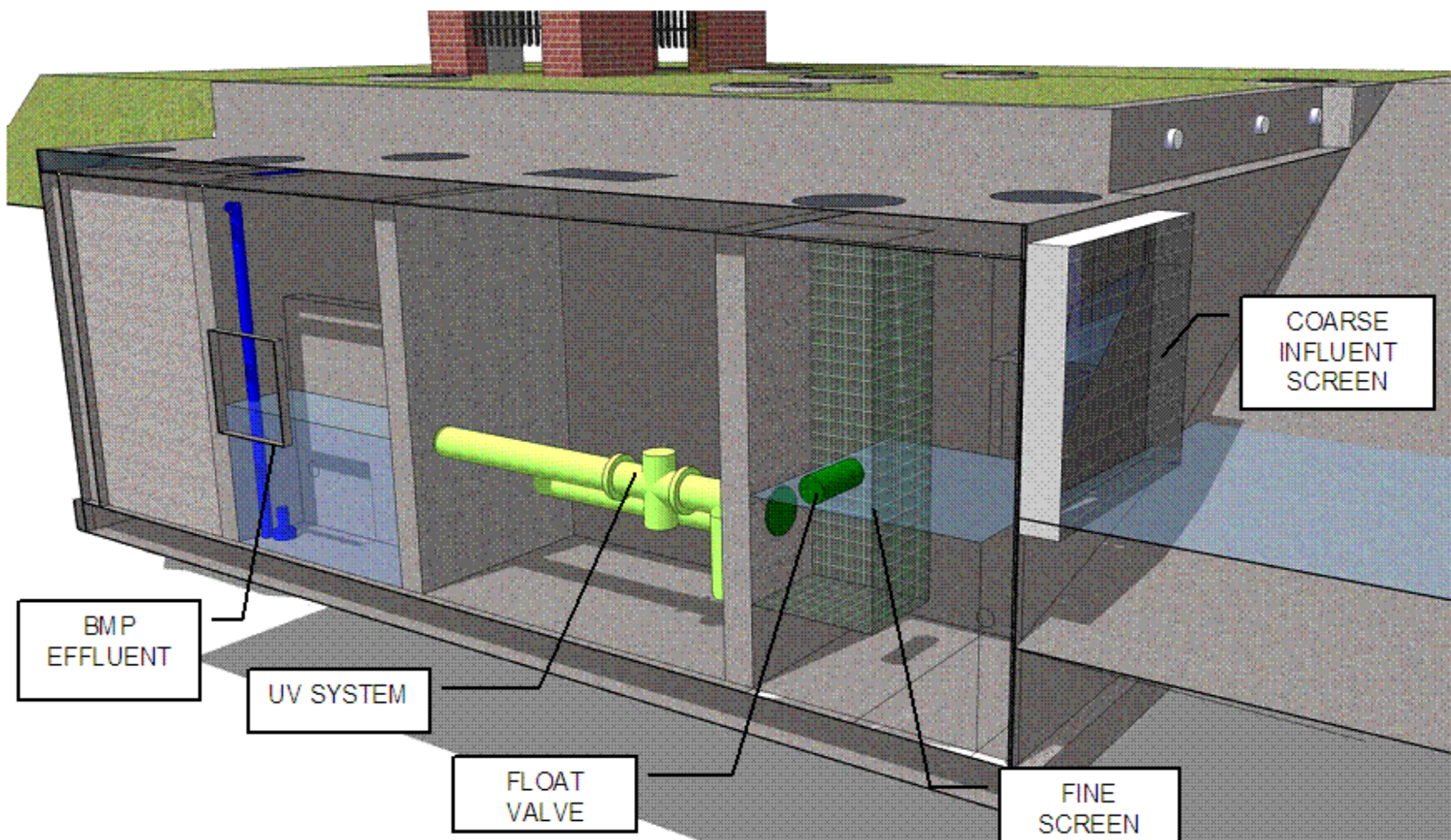








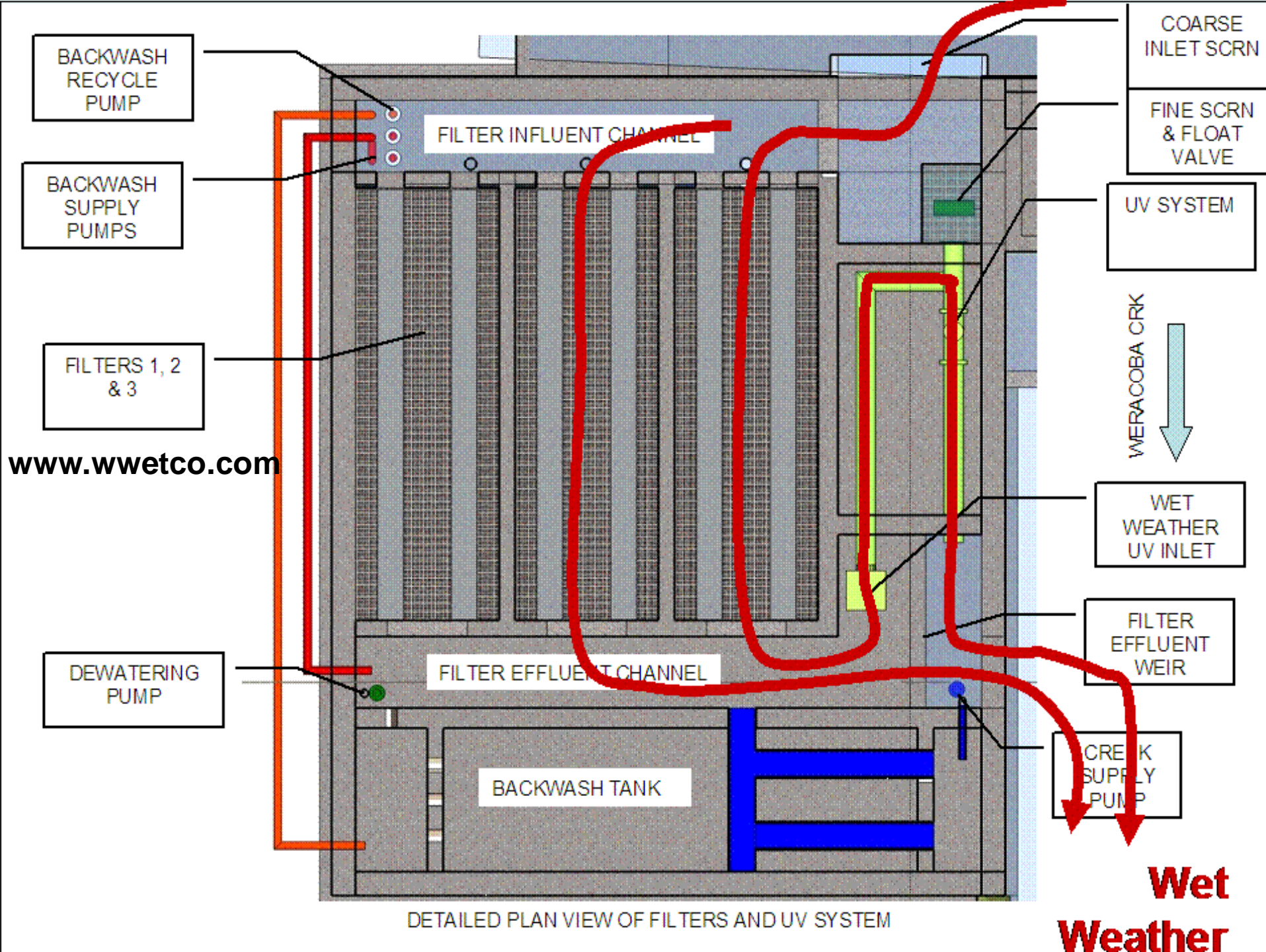




NORTH-SOUTH SECTION CUT THROUGH THE UV SYSTEM, LOOKING EAST. DRY WEATHER FLOW ENTERS THROUGH THE INFLUENT SCREEN, FINE SCREEN AND THE UV SYSTEM PRIOR TO DISCHARGING TO CREEK



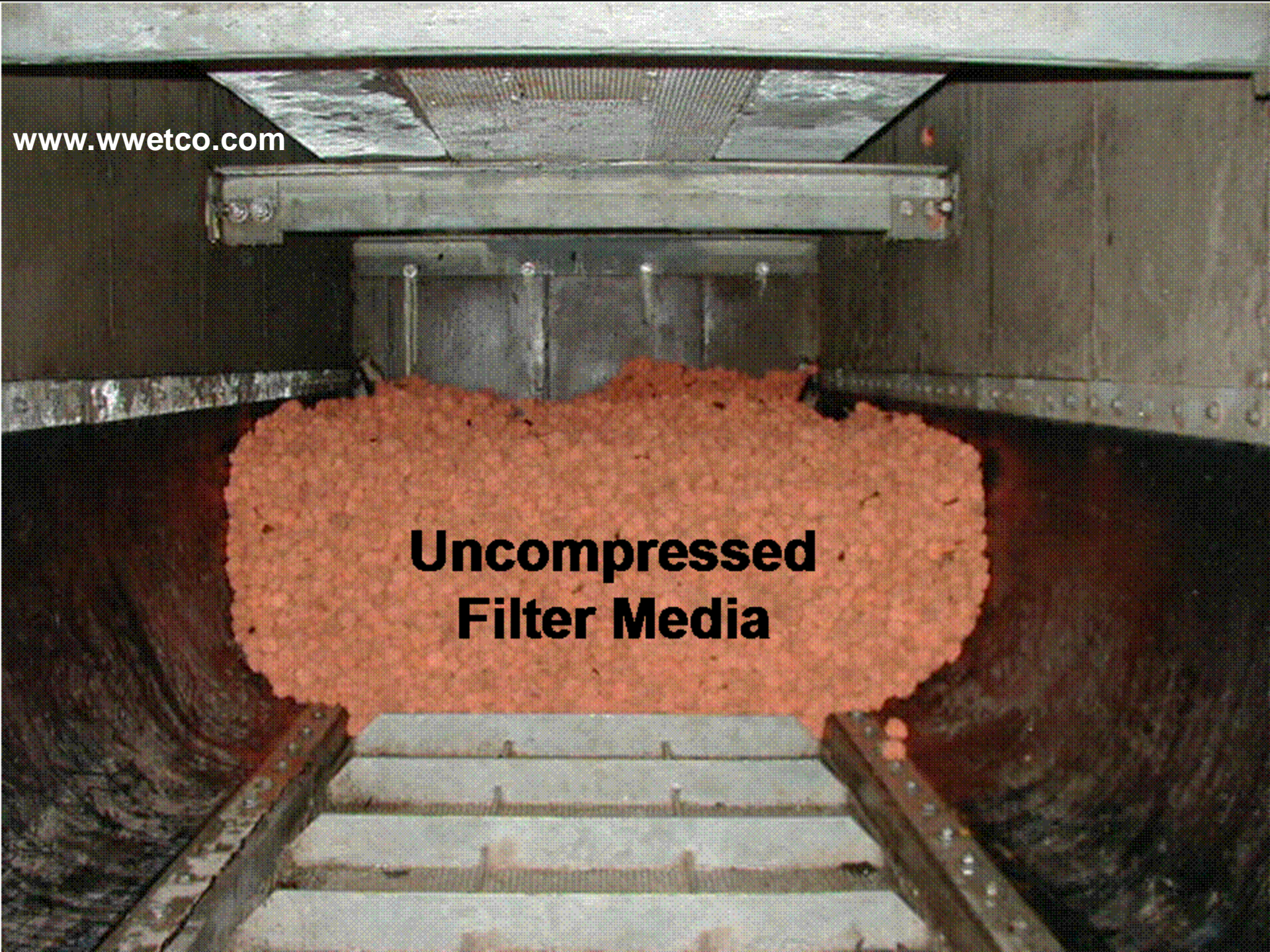






[www.wwetco.com](http://www.wwetco.com)

**Uncompressed  
Filter Media**







**Compressed  
Filter Media**



















# **Columbus BMP Performance Requirements**

- **MS4 Permit Requirements for Sampling**
- **TMDL Requirements to Reduce Bacteria Loads to Meet Stream Standards**
- **TMDL Requirements to Improve Macro-Invertebrate Community**

# **First Year Results**

- **35% Annual Solids Yield Reduction**
- **Up to 80% Fecal Coliform Load Reduction**
- **Macro-invertebrate re-colonization to Improve Stream from Class C to Low A or High B**
- **Reduced Fecal Coliform 30-Day Geometric Mean Excursions to below 10% Criteria**

# Columbus BMP Costs

Component	Total Cost	Cost Per Acre Served	Cost Per lb TSS and Sediment Removed	Cost Per 10 Million Fecal Coliform Inactivated
<b>BMP Capital</b>	<b>\$875,000</b>	<b>\$648</b>		
<b>Annualized BMP Capital</b>	<b>\$76,000</b>	<b>\$57</b>	<b>\$0.18</b>	<b>\$0.02</b>
<b>Annual BMP O&amp;M</b>	<b>\$64,000</b>	<b>\$47</b>	<b>\$0.15</b>	<b>\$0.01</b>
<b>Total Annual Costs</b>	<b>\$140,000</b>	<b>\$104</b>	<b>\$0.34</b>	<b>\$0.03</b>

BMP service area is 1,350 acres. Annual TSS and sediment removal is 416,000 lbs. Annual fecal coliform inactivation is 4.3 million.



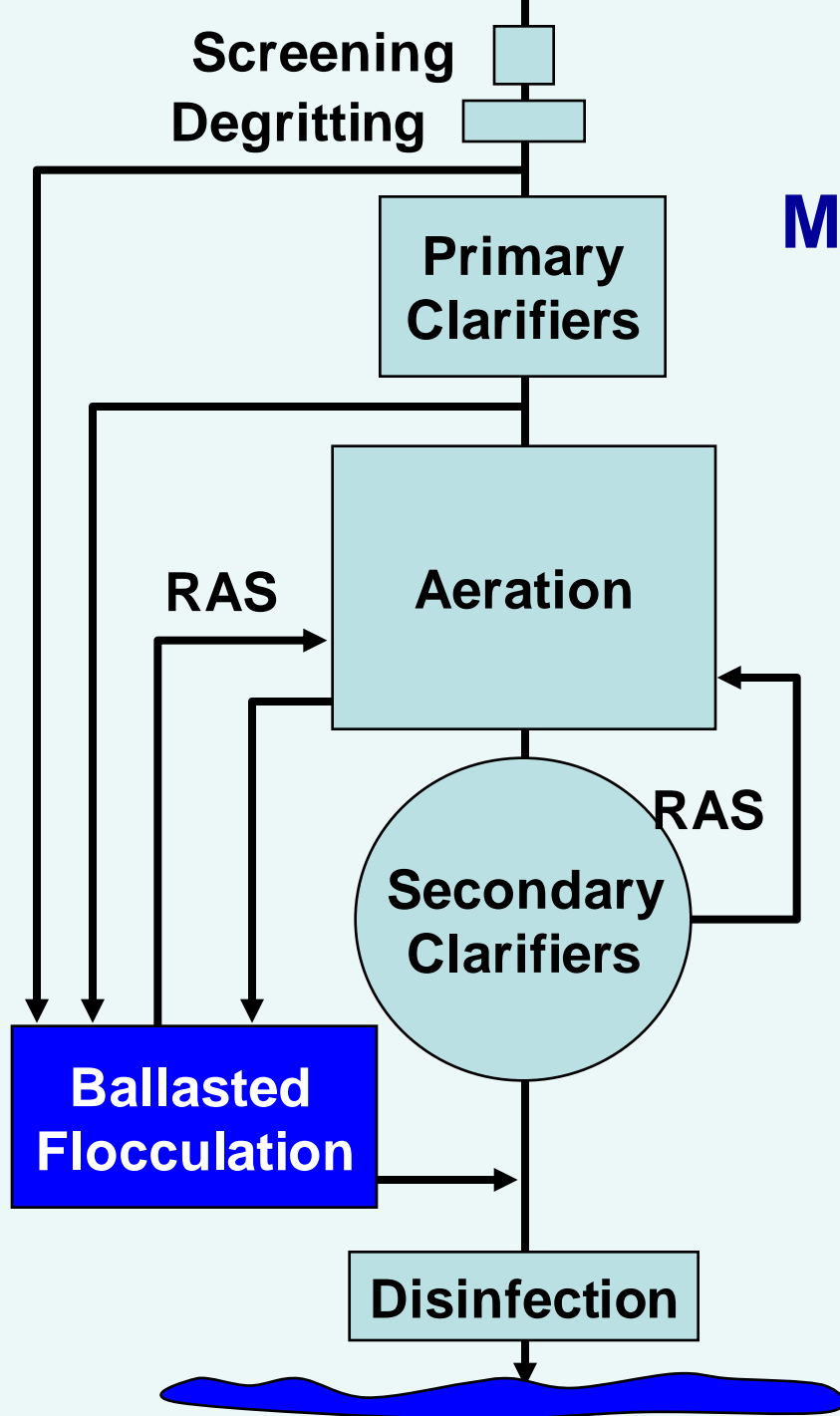
## **Poll Question 2:**

**How many people are participating in the webcast today at your location?**

- A) Just me
- B) 2 to 5
- C) 6 to 10
- D) 10 to 20
- E) More than 20

***Questions?***

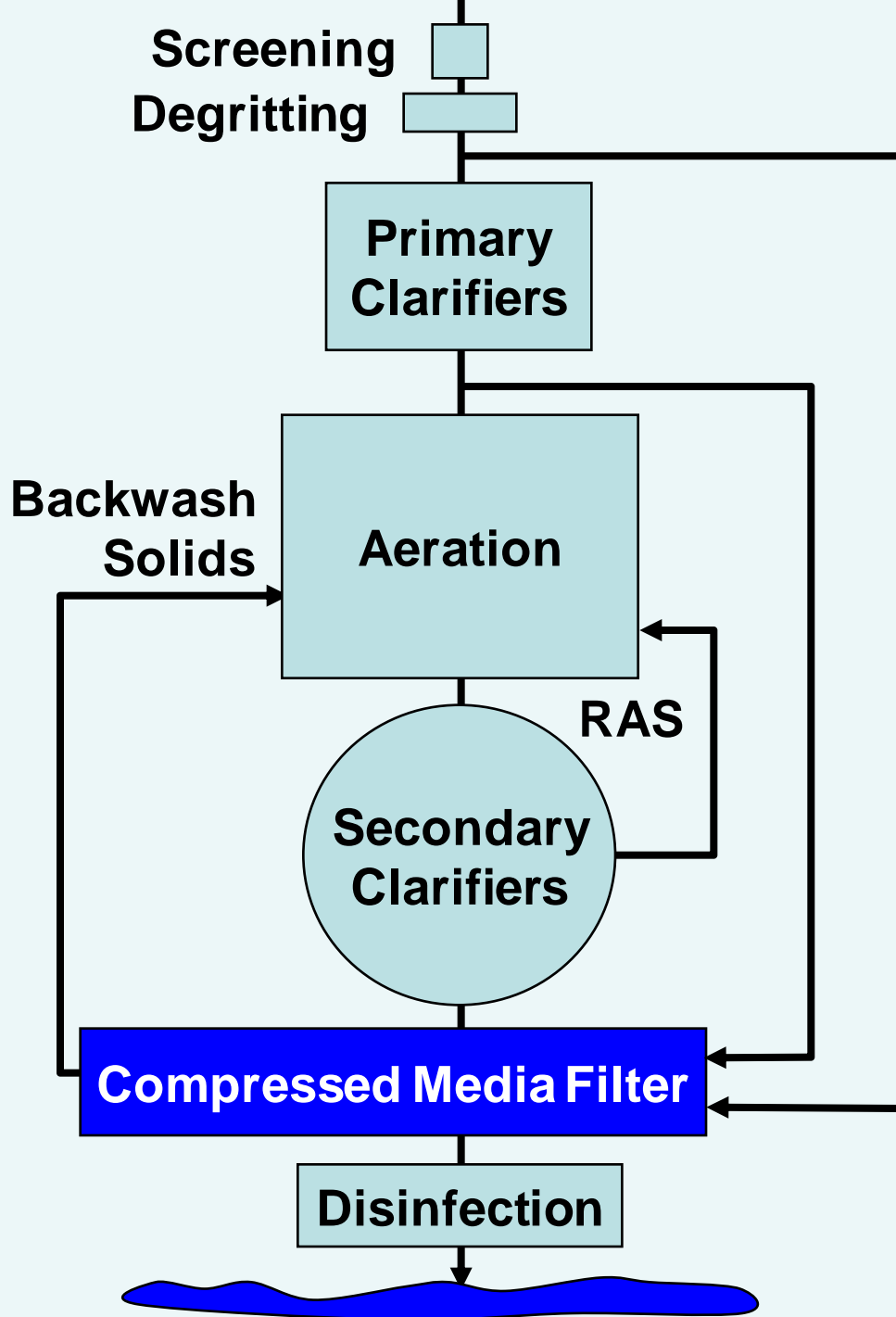
# Multi-Purpose Process to Maximize Biological Treatment at the POTW



## Technology Functions:

1. Separation technology paralleling secondary clarifiers during dry weather
2. High rate MLSS separation during wet weather
3. Excess primary treatment
4. Excess screened and degritted flow treatment

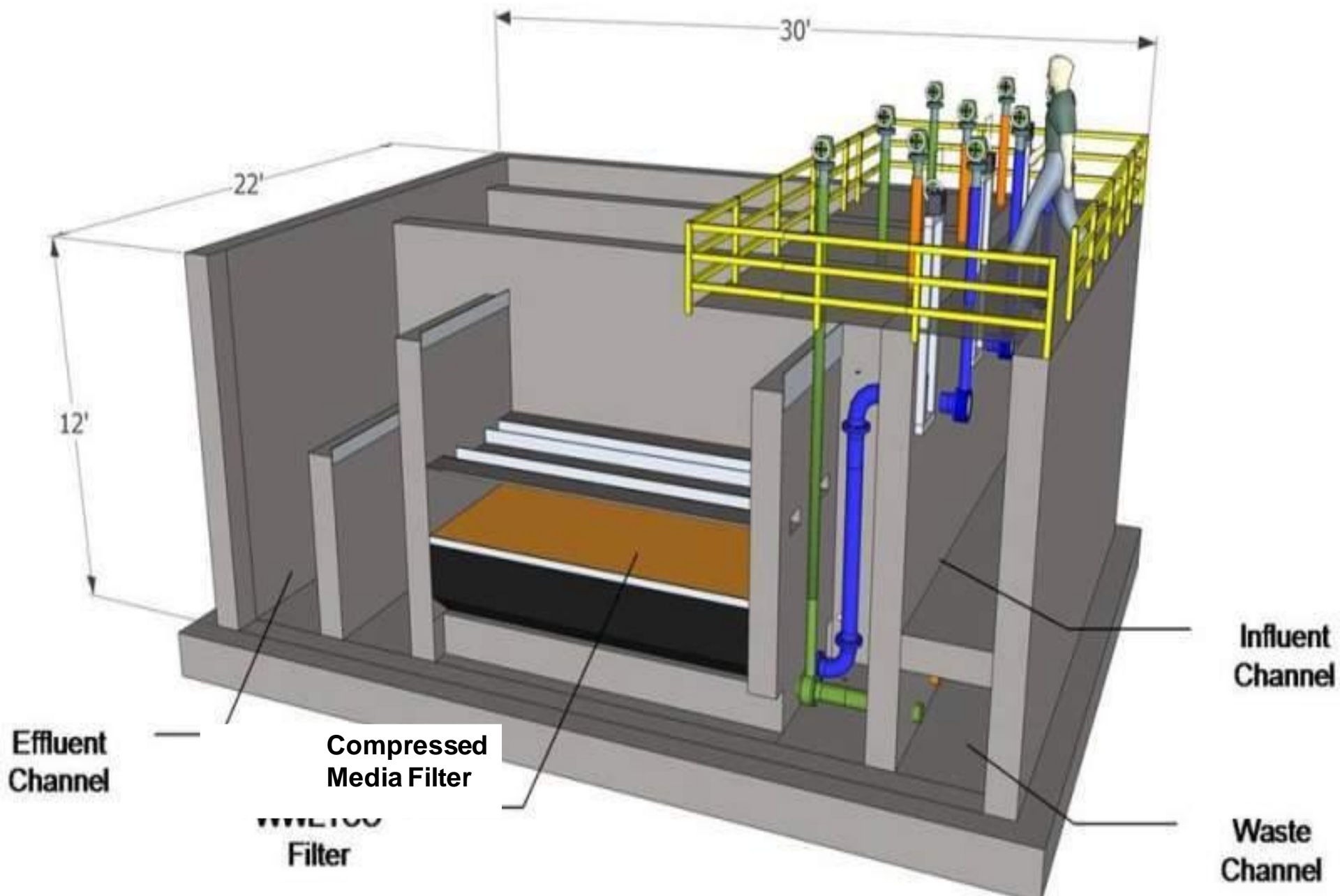




## Multi-Purpose Process to Maximize Biological Treatment at the POTW

### Technology Functions:

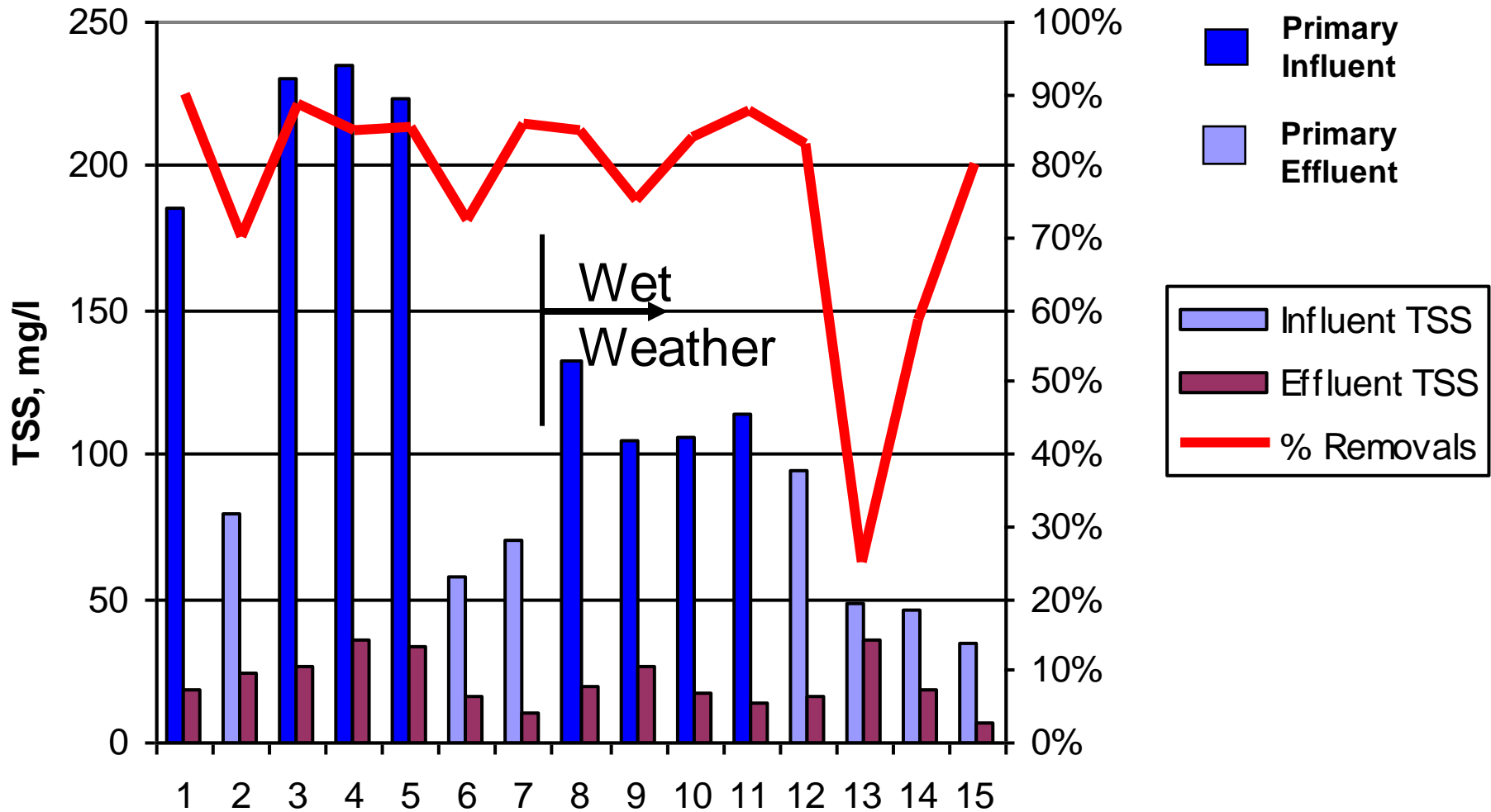
1. Tertiary Filtration During Dry Weather
2. Tertiary Filtration During Wet Weather Capturing MLSS Overflow From Clarifiers During High Rate Biological Treatment
3. Excess Primary Filtration
4. Excess Screened and Degritted Filtration



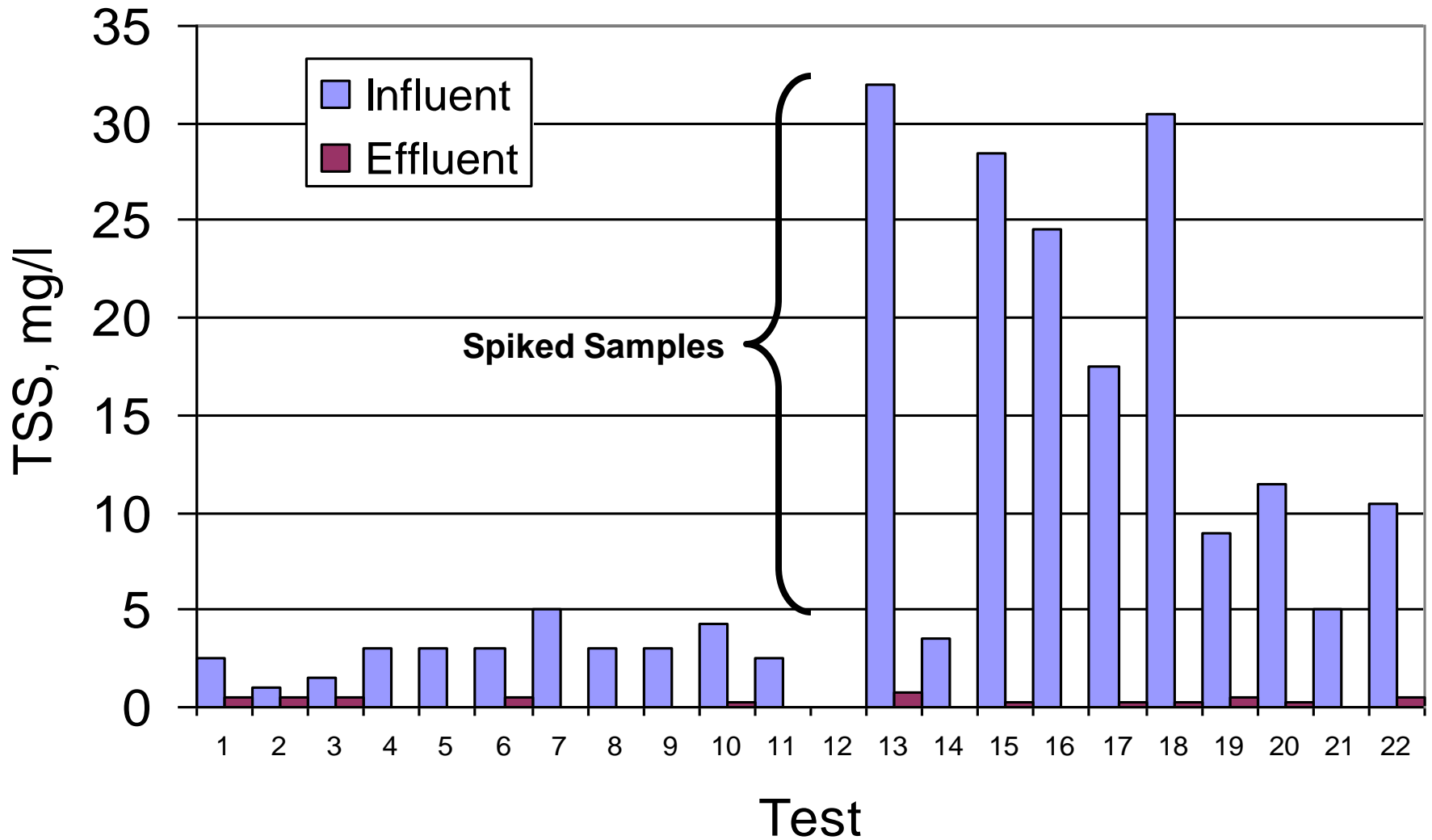




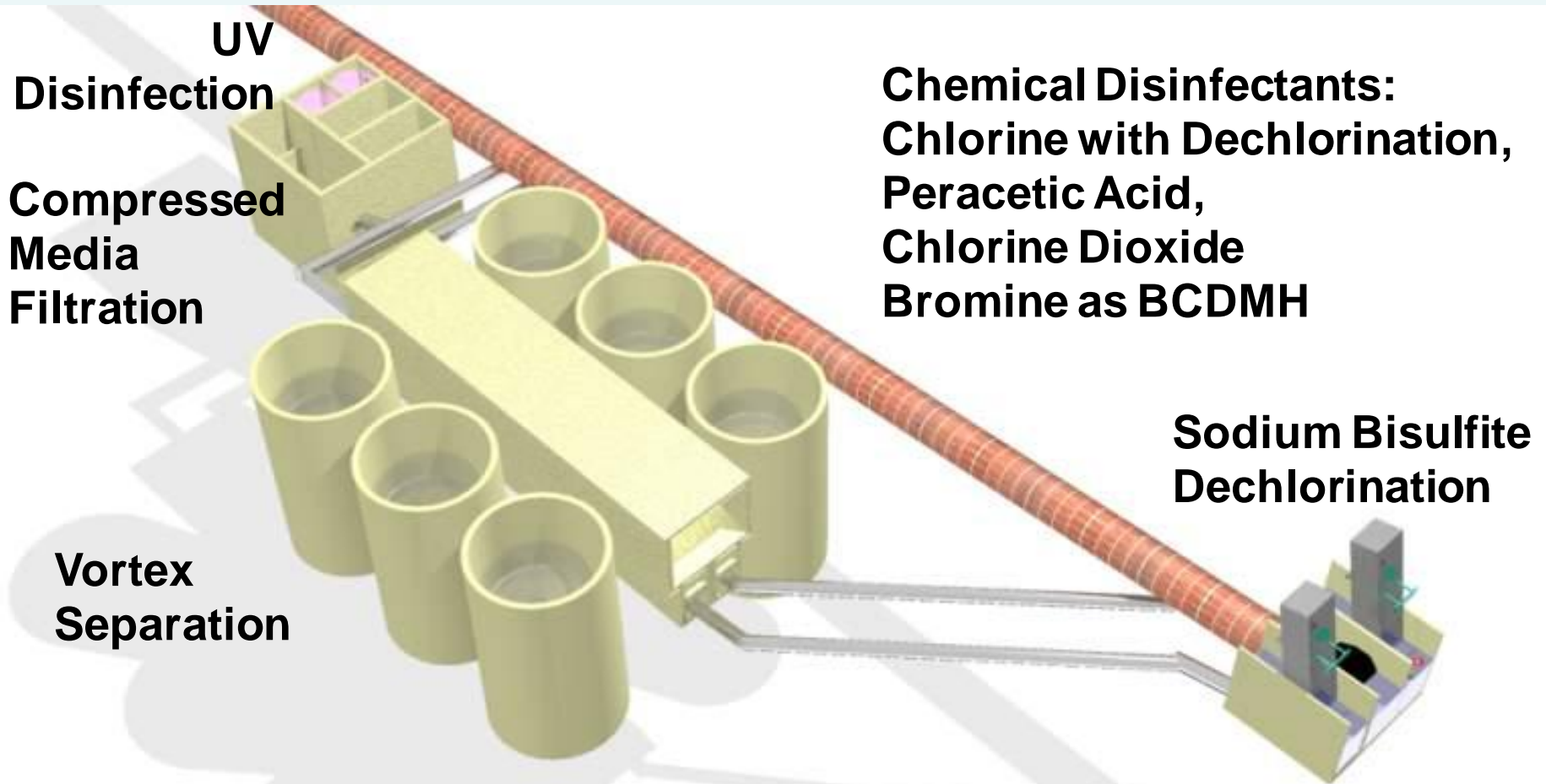
# Recent Independent Testing at POTW Primary Influent and Primary Effluent WWETCO Filter- TSS Removals



## Secondary Clarifier Effluent Testing TSS



# Columbus, GA CSO Demonstration Program

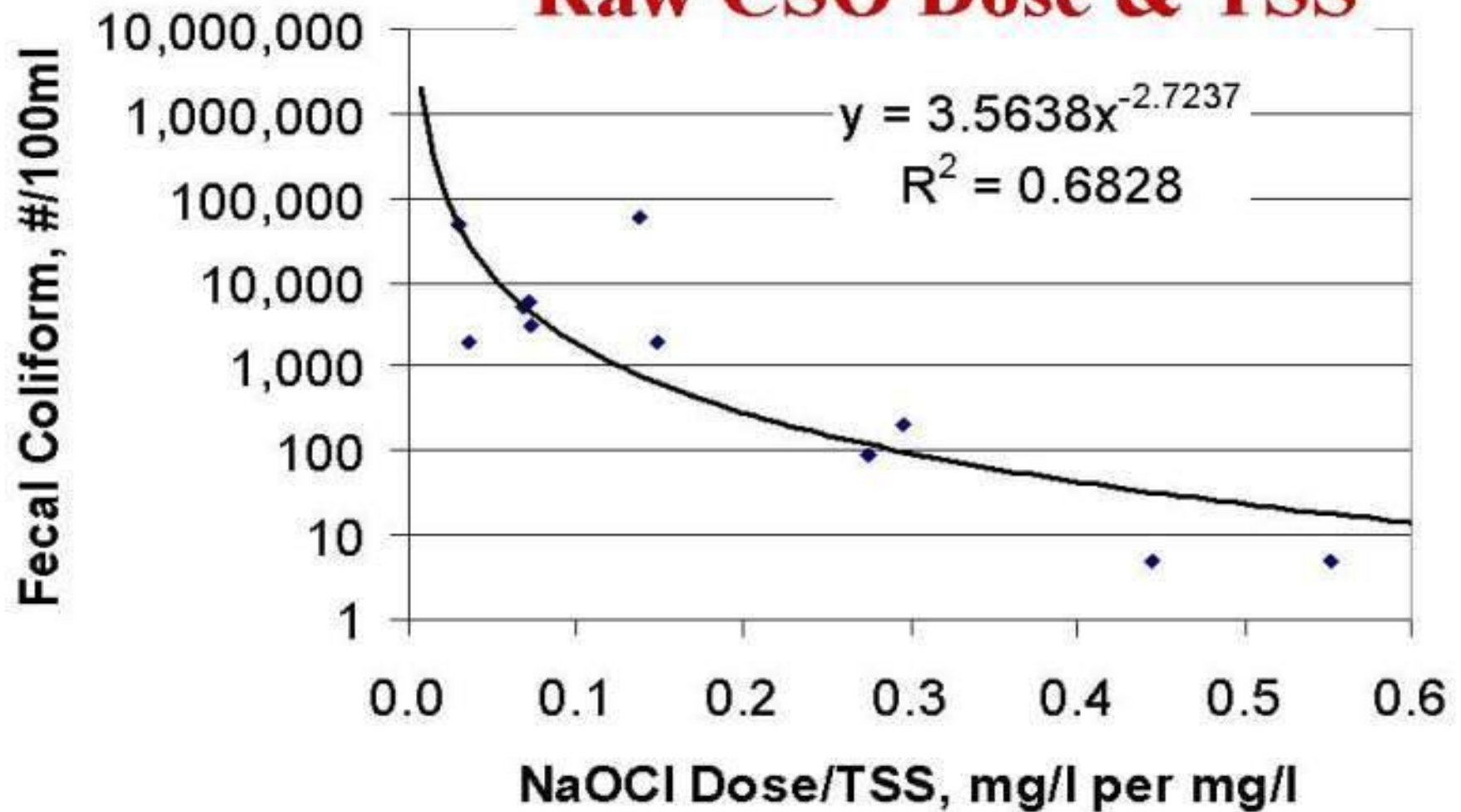


- *UV Effluent up to 12 MGD Fecal Coliform < 100 #/100ml*
- *Chlorinated/Dechlorinated Effluent up to 48 MGD < 100#/100ml*



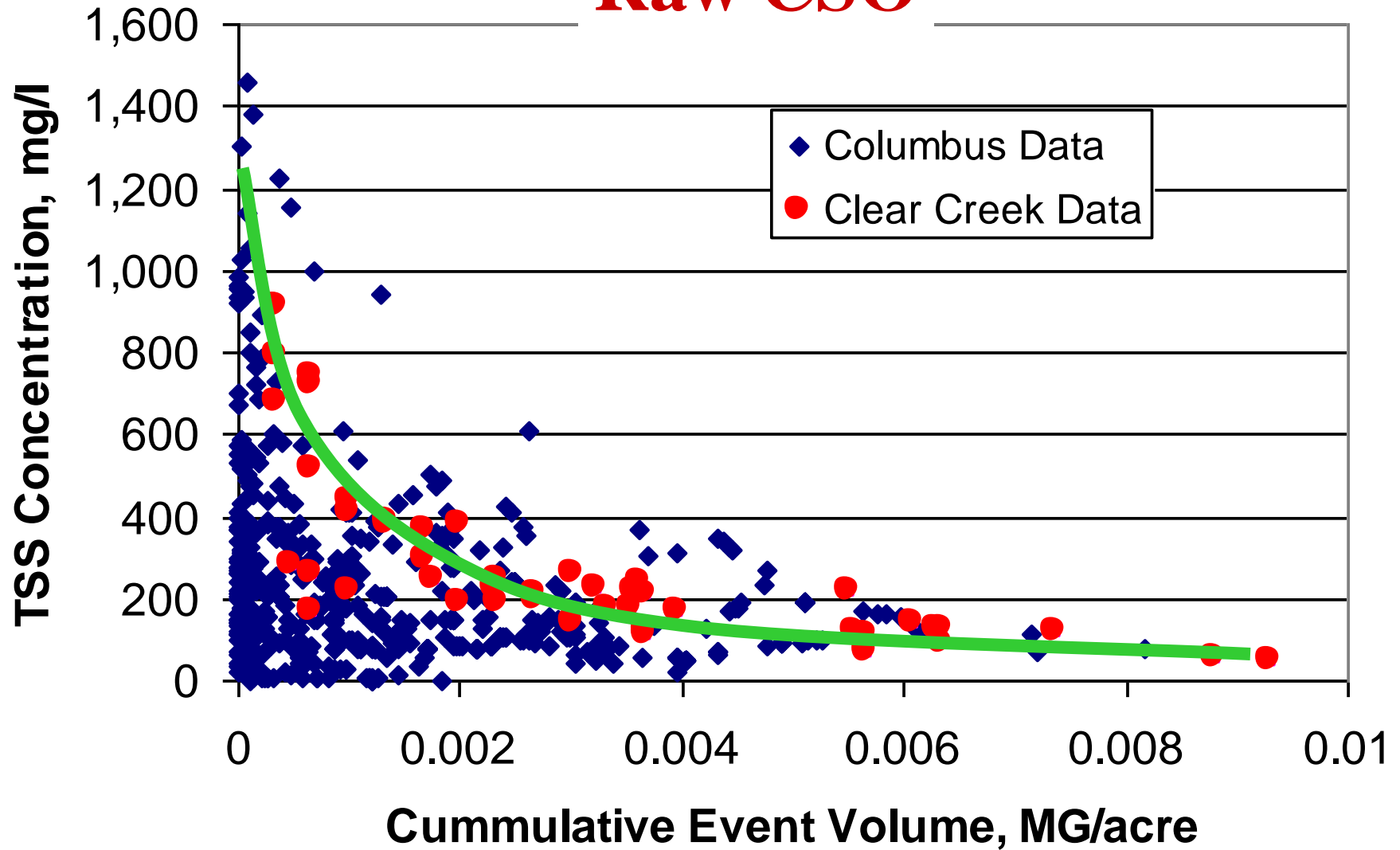
# Dose-Response Normalized by TSS Raw CSO Samples

## Raw CSO Dose & TSS

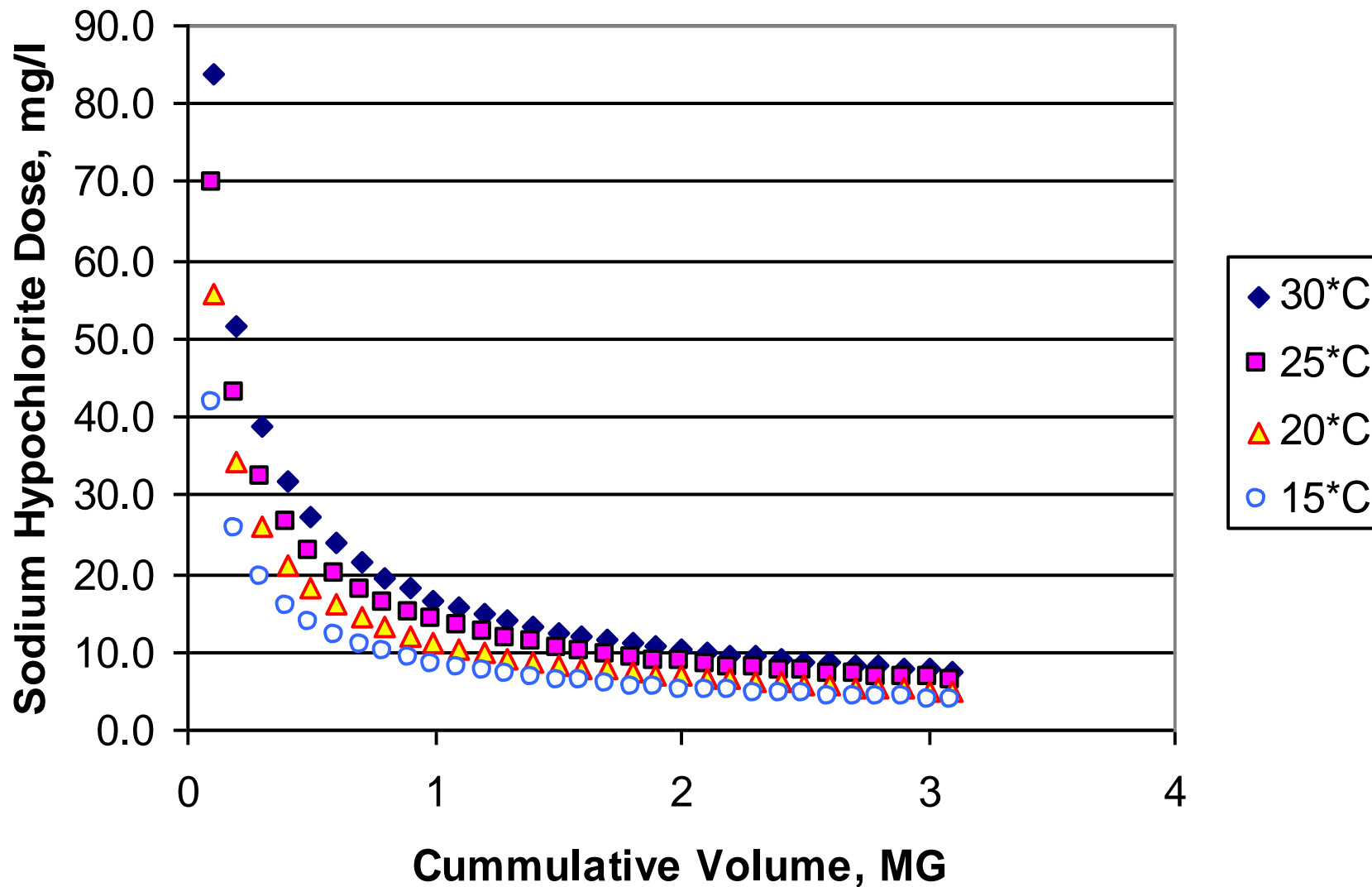


# CSO Volume vs TSS Concentration, mg/l

**Raw CSO**



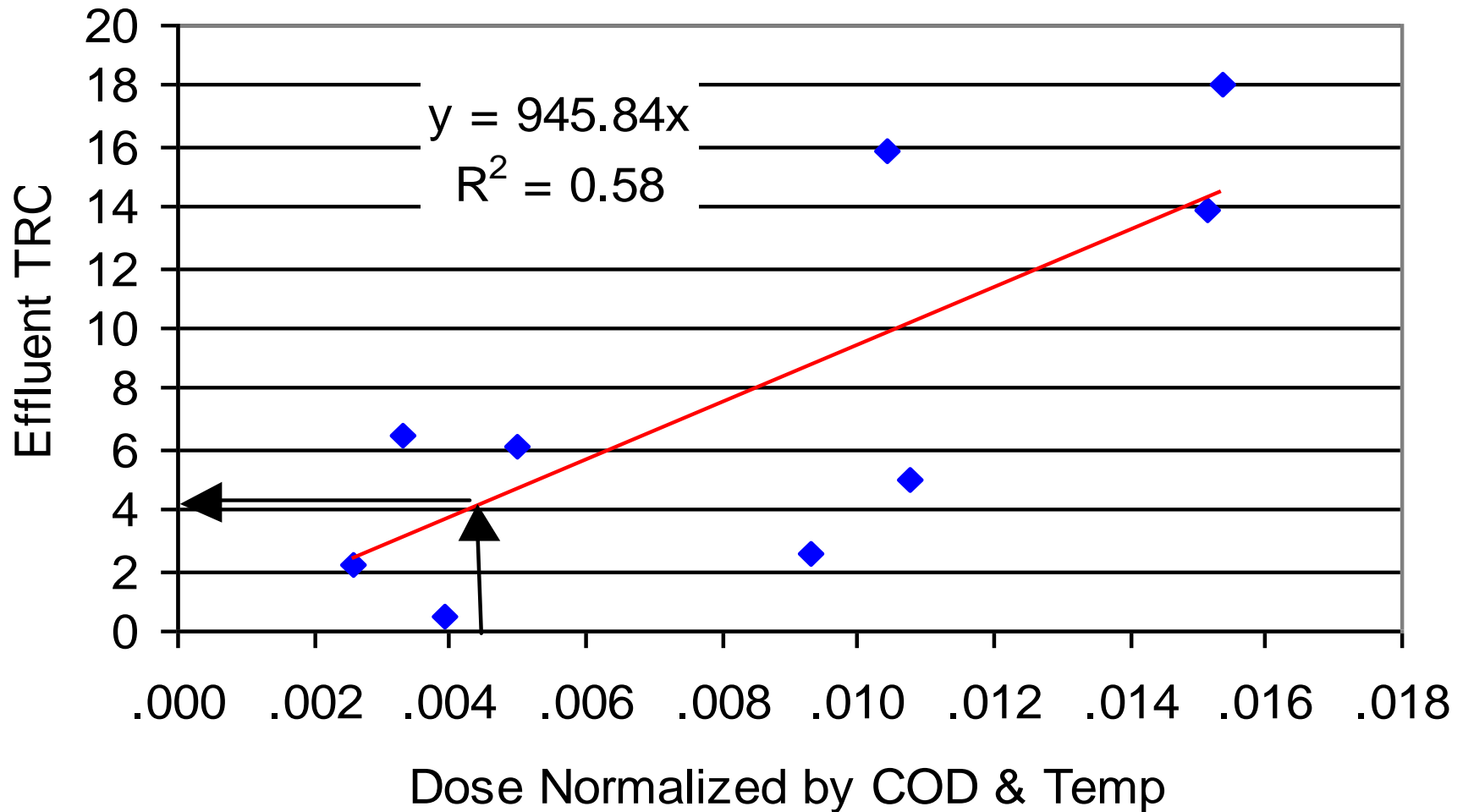
# Dosing Feed Curves Based on Wastewater Temperature and Cumulative CSO Volume





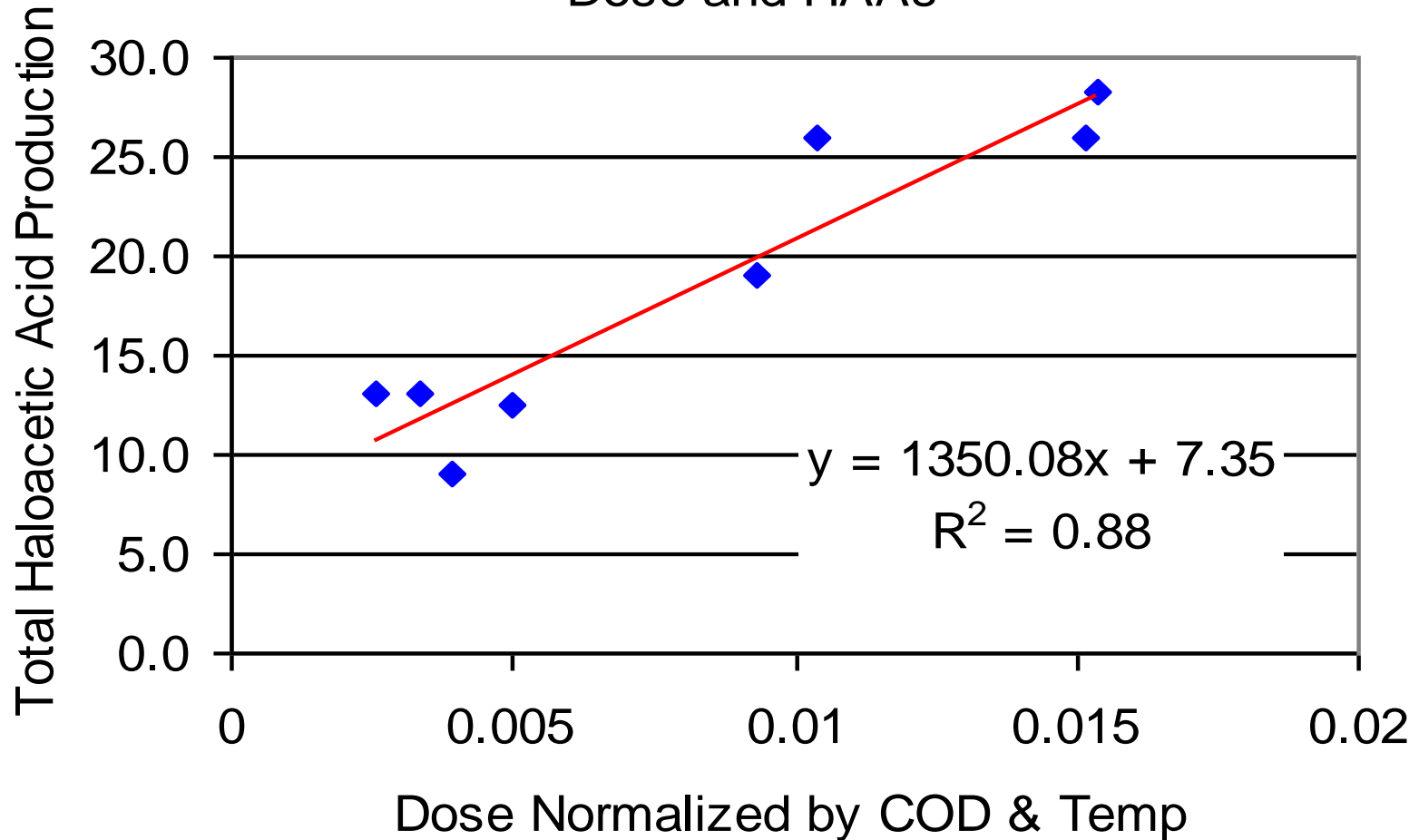
## Sodium Hypochlorite Dose and TRC

### Dose, COD & Temp



18.1 mg/l dose normalized by COD and Temp.

## Sodium Hypochlorite Dose and HAAs



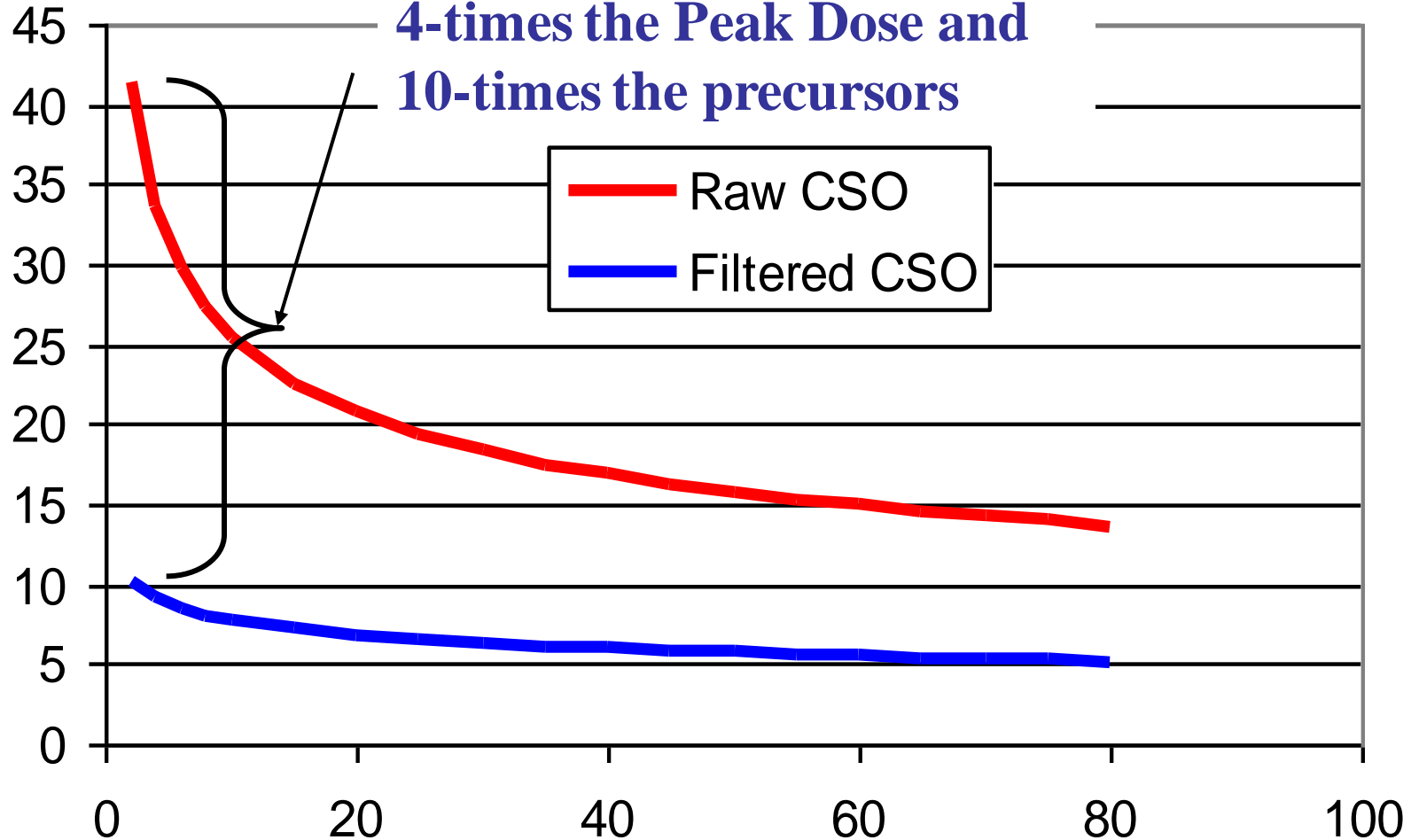
**Dose, COD & Temp**

# Direct Disinfection of CSOs

## Raw CSO Disinfection

4-times the Peak Dose and  
10-times the precursors

Sodium Hypochlorite Dose,  
mg/l



Cumulative CSO Volume, MG



# Disinfection Conclusions

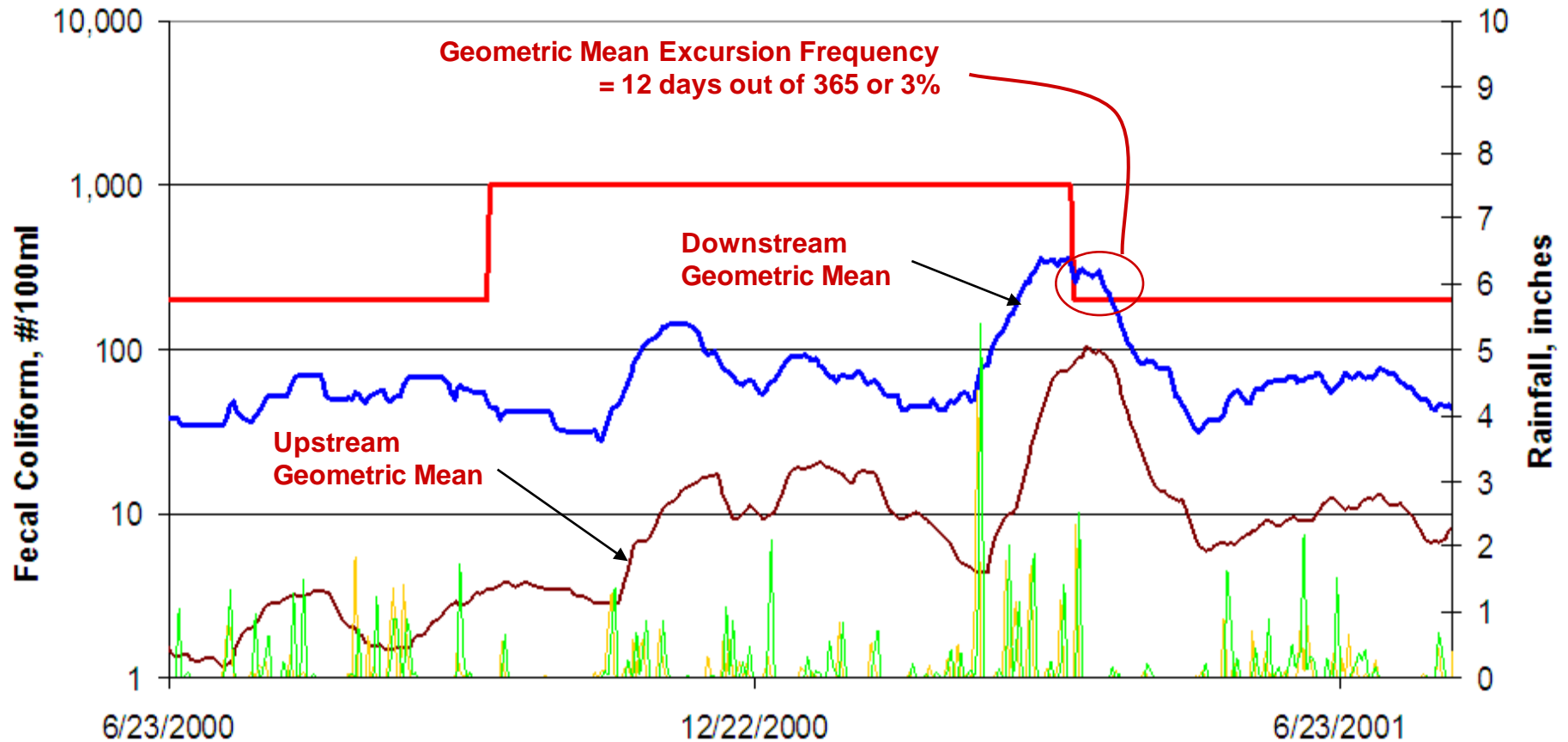
- **Chemical and UV disinfection can be defined as a function of wastewater quality and temperature**
- **Wet weather quality is rapidly changing but predictable for disinfection control**
- **Oxidant dose versus TRC can be used to control the dechlorination feed control**
- **DBPs are a function of dose and quality**
- **DBPs production can be reduced through UV disinfection or precursor reduction**

# Impaired Water Definitions\*

- **Excursion:** when the 30-day geometric mean is higher than the water quality standard
- **Digression:** when a single sample maximum value is higher than the water quality standard
- **Exceedance:** when excursions or digressions are greater than the allowed frequency
- **Impairment:** when there is an exceedance of one or more numeric water quality standards

*\*Guidance for 2006 Assessment, Listing and Reporting Requirements, p. 67*

# Chattahoochee River at Columbus, GA, Showing Upstream and Downstream Fecal Coliform Output From Calibrated BASINS Model versus Standards



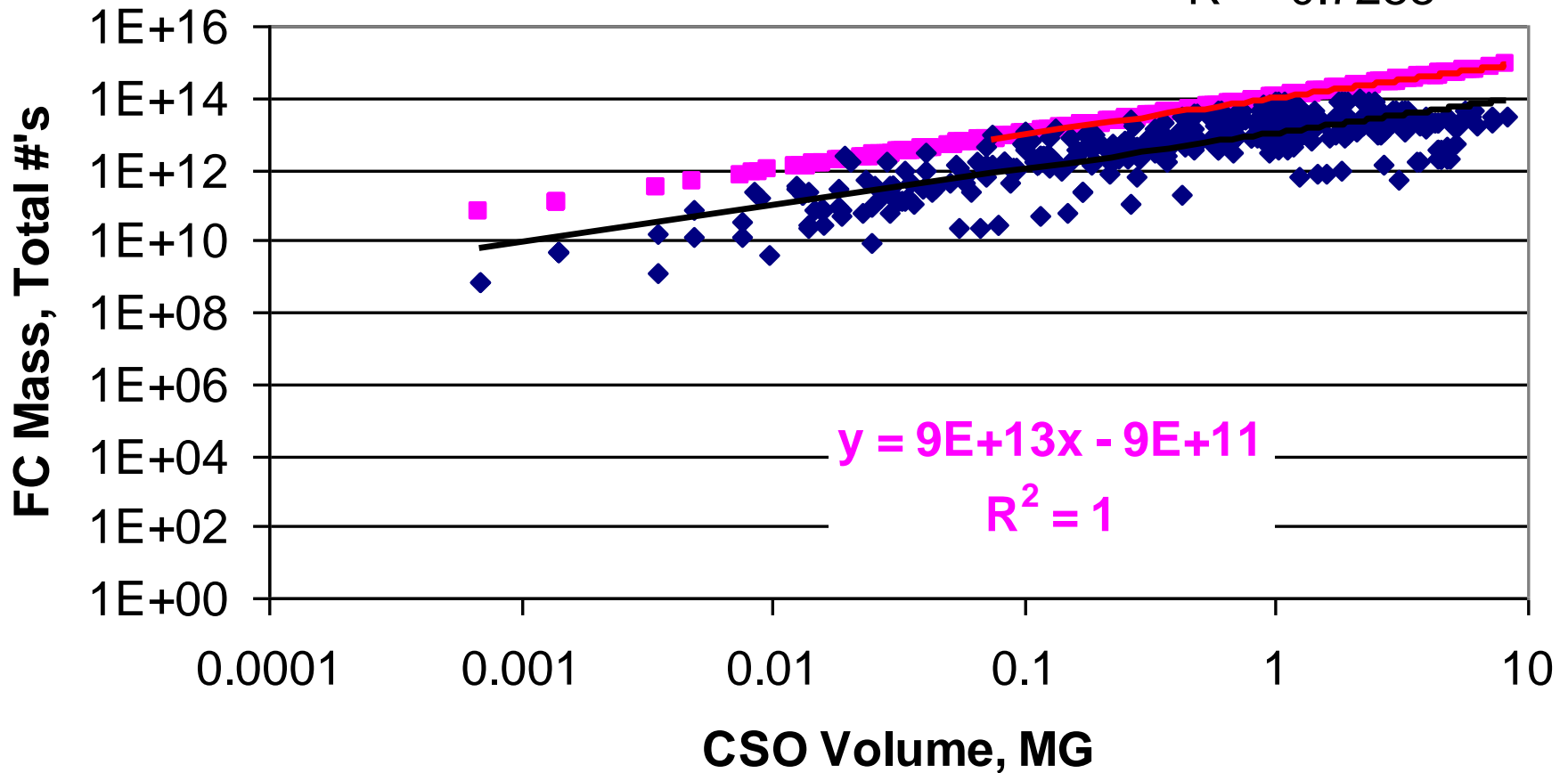
- 30-day Geometric Std
- 30-Day Geometric Mean of Upstream Conditions
- South Commons Rain Gage
- 30-Day Geometric Mean of Model Values
- Airport Rain Gage



# CSO Bacteria Contributions to TMDL Analysis

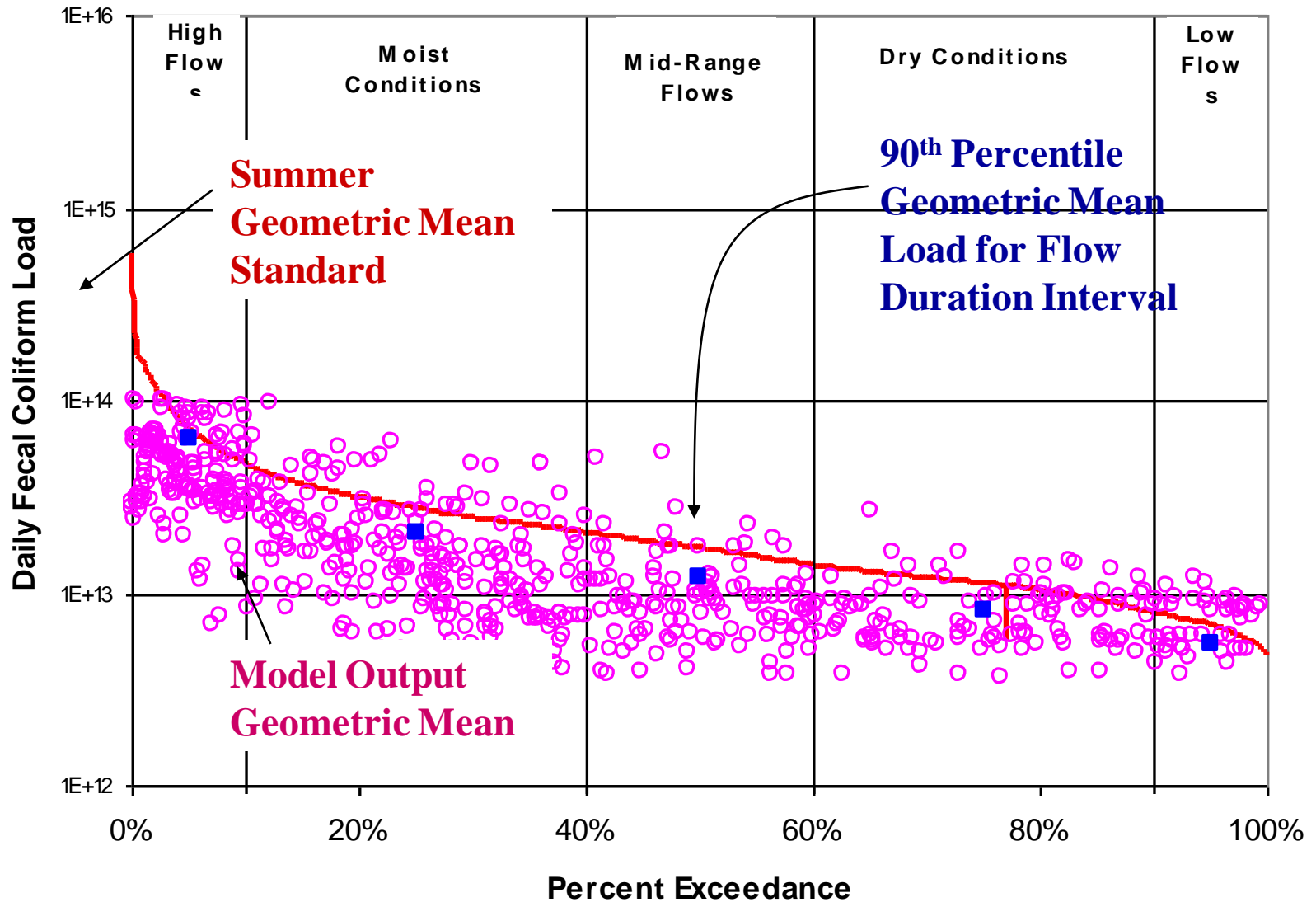
CSO Volume vs Total FC #'s

$y = 1E+13x^{1.0103}$   
 $R^2 = 0.7288$



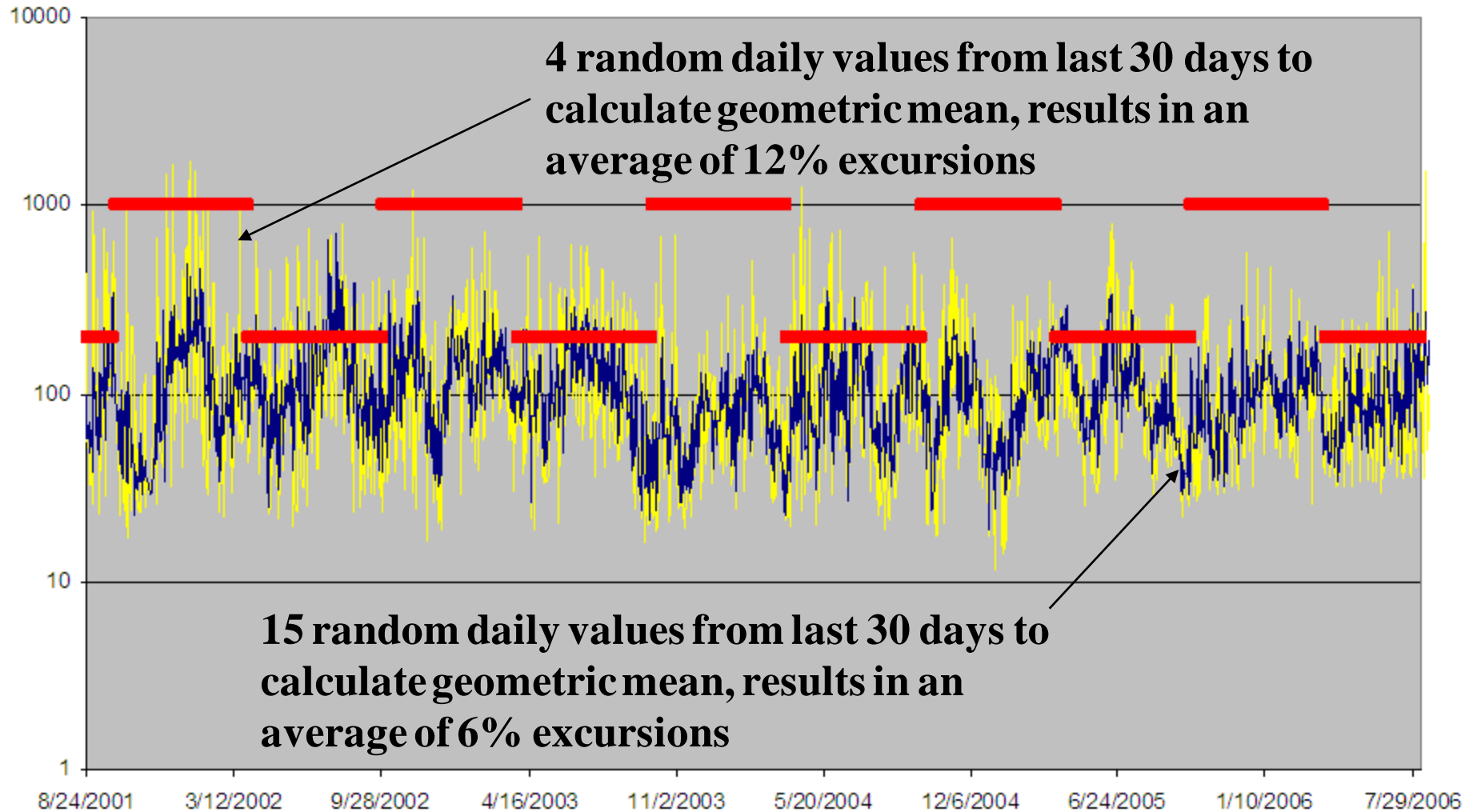
■ Outer Limit    ◆ CSO Volume    — Power (CSO Volume)    — Linear (Outer Limit)

# EPA Load



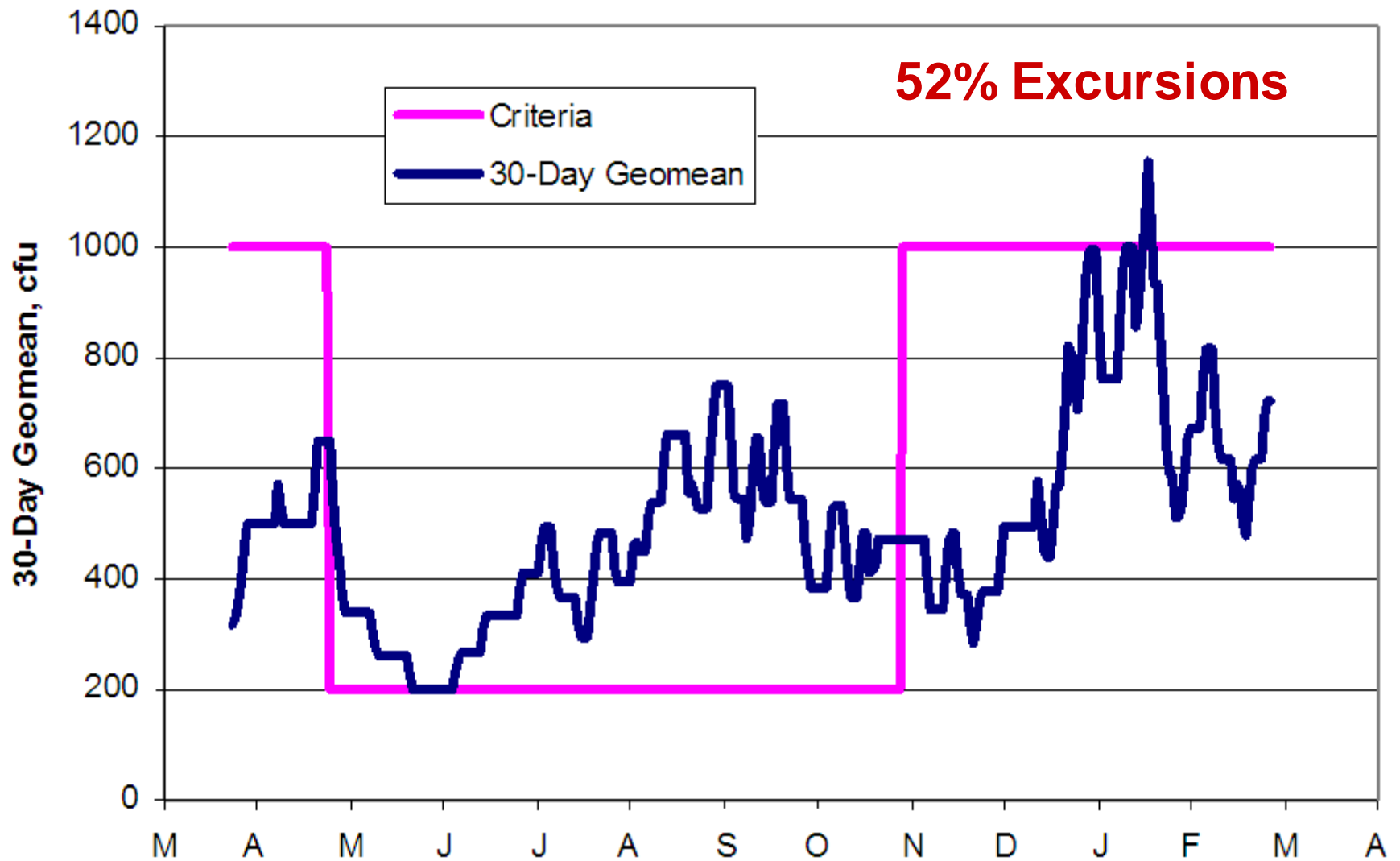
# EPA BASINS Model Output

**Comparison of Random 4-day Samples Having 12% Excursions  
and Random 15-day Samples Having 6% Excursions**



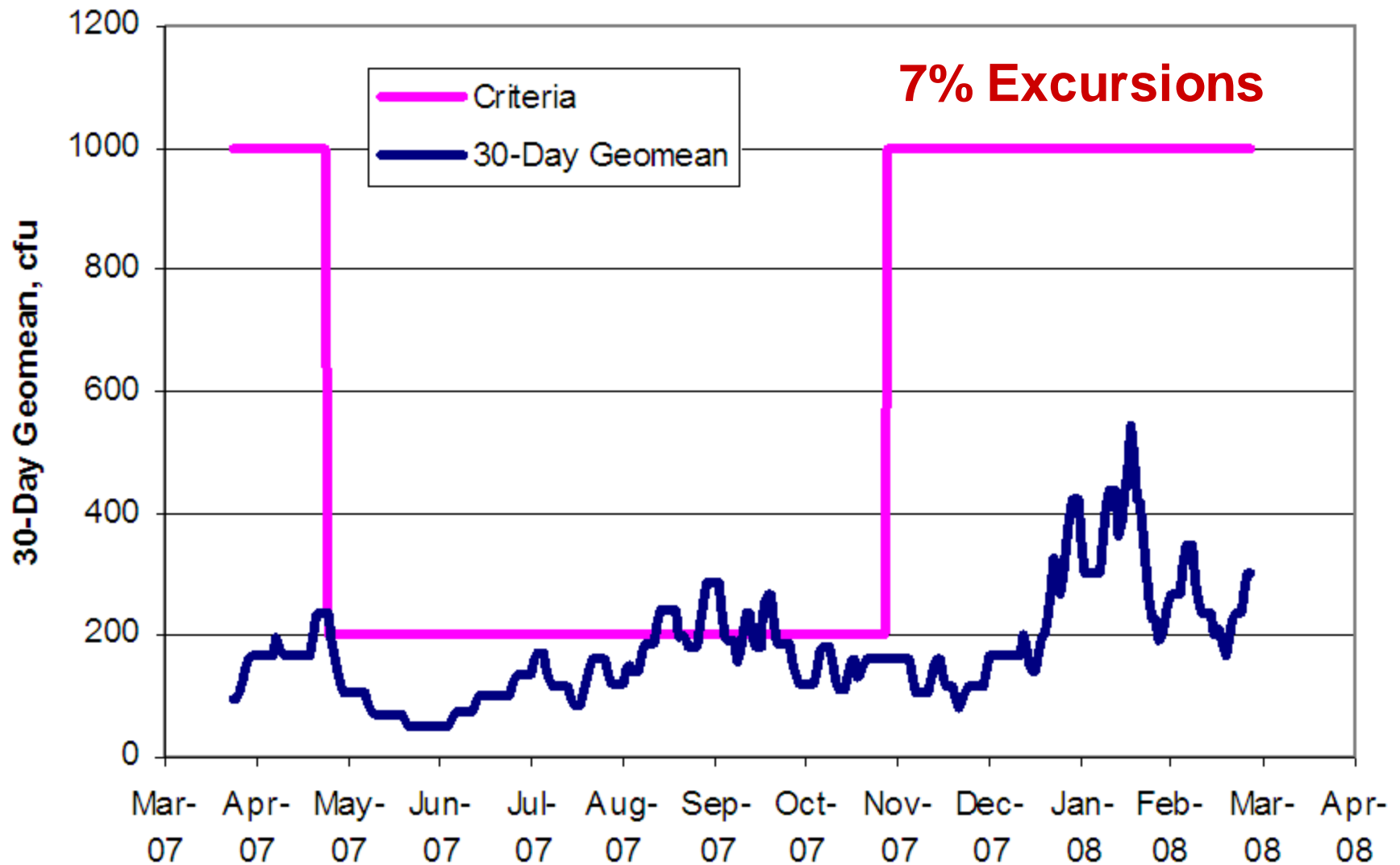


# 30-Day Geomean without BMP Dry Weather Bacteria at 200 #/100ml



# 30-Day Geomean with BMP

## Dry Weather Bacteria at 50 #/100ml



***Questions?***



# Participation Certificate

If you have multiple attendees, click the link to download the certificate to your computer. You can type the attendees name in the name field and then print the certificate.

[www.epa.gov/npdes/webcasts/certificate/  
cso\\_control\\_technologies2.pdf](http://www.epa.gov/npdes/webcasts/certificate/cso_control_technologies2.pdf)